NASA News

National Aeronautics and
Space Administration

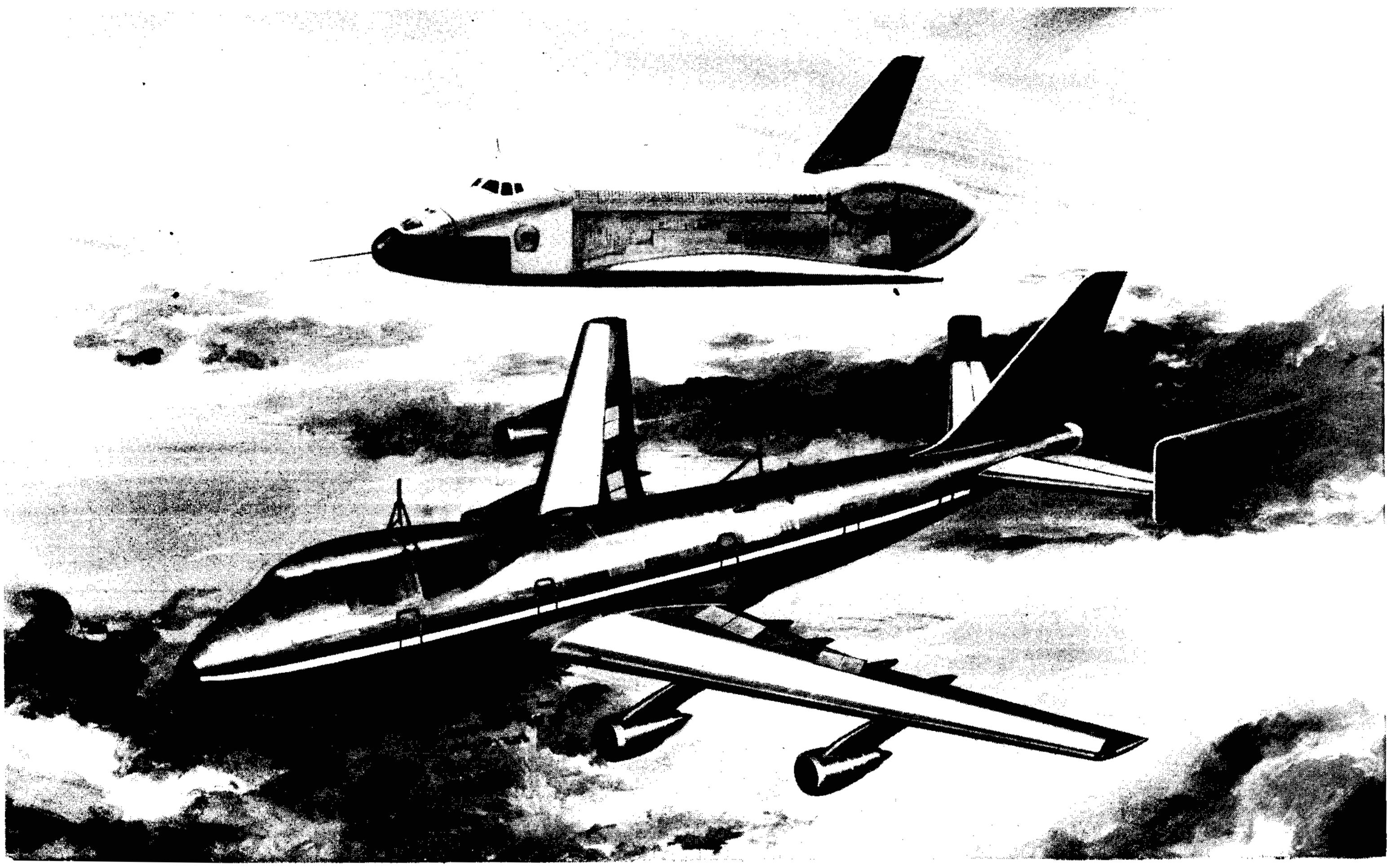
Washington, D.C. 20546
AC 202 755-8370

Press Kit

For Release IMMEDIATE

Project SPACE SHUTTLE ORBITER TEST FLIGHT SERIES

RELEASE NO: 77-16



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SPACE SHUTTLE ORBITER TEST FLIGHT SERIES TO BEGIN

The Space Shuttle orbiter will fly this year following a series of test taxi runs and captive flight tests while still attached to its carrier airplane. In February, a year-long series of low altitude flights to verify the aerodynamic and flight control characteristics of the first Shuttle Orbiter will take place at NASA's Dryden Flight Research Center, Edwards, Calif.

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Mailed:
February 4, 1977

two solid rocket boosters and an external fuel tank which feeds the Orbiter's three engines.

These Orbiter test flights, the Approach and Landing Tests (ALT), are under the management of NASA's Johnson Space Center, Houston, Tex., and are being conducted at Dryden Center and the Air Force Flight Test Center (AFFTC) located at Edwards Air Force Base, Calif. This test site has several distinct advantages including a 4,570-meter (15,000-foot) long by 90-m (300-ft.) wide paved runway, in addition to lakebed runways which are extremely long and wide.

ALT is a series of flights with a modified Boeing 747 Shuttle Carrier Aircraft (SCA) serving as a ferry aircraft and airborne launch platform for the 67,500-kilogram (75-ton) Orbiter, named the Enterprise. The tests begin with several taxi tests of the SCA, with the Orbiter atop, followed closely by a series of six inert captive flights with the jumbo jet carrying the unmanned Orbiter to altitudes of 7,620 m (25,000 ft.).

The unmanned Orbiter captive flights are to verify performance of the two vehicles in mated flight. They will be followed by five captive active flights in which the Orbiter systems will be powered up and the Enterprise will be manned by two NASA astronauts.

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These active flights are designed to verify crew procedures and systems operations. Actual release of the Orbiter from the SCA first occurs in a subsequent series of flights.

Up to eight free flights are scheduled with the SCA serving as the airborne platform from which the Orbiter will be launched. These flights, with NASA astronauts at the controls of the unpowered Orbiter, are designed to verify the Orbiter's subsonic airworthiness, integrated systems operations and pilot-guided and automatic approach and landing capabilities.

The Orbiter, workhorse of the Space Shuttle program, is designed to be used a minimum of 100 times. It is as big as a commercial jetliner (DC-9); its empty weight is 68,000 kg (150,000 lb.); it is 37.2 m (122 ft.) in length and it has a wingspan of 23.8 m (78 ft.). The Orbiter is to be launched into low Earth orbit early in 1979, with its three main engines being augmented by a pair of solid rocket boosters.

The Space Shuttle is composed of the Orbiter, the two solid rocket boosters and an external fuel tank which feeds the Orbiter's three engines.

The Orbiter is attached to the back of the fuel tank and the solid boosters are attached to each side of the external tank. The solid boosters will be recovered, refurbished and reused. The external tank will be jettisoned, but not recovered.

Enterprise, the first Orbiter (101) be used in the Dryden flight test program, is the first development article of the Shuttle program to come off the assembly line. Under construction since June 19, 1974, the Enterprise's main parts come from numerous aerospace contractors throughout the country. The crew module and aft fuselage were fabricated by the prime contractor, Rockwell International's Space Division, Downey, Calif.; the mid-fuselage (cargo bay) by General Dynamics, San Diego, Calif.; wings by the Grumman Aerospace Corp. of Bethpage, N.Y.; and its tail assembly by the Fairchild Republic Co., Farmingdale, N.Y.

The Orbiter's three main engines, each of which provide 2.1 million newtons (470,000 lb.) of thrust at launch, are being built by the Rocketdyne Division, Rockwell International, Canoga Park, Calif.

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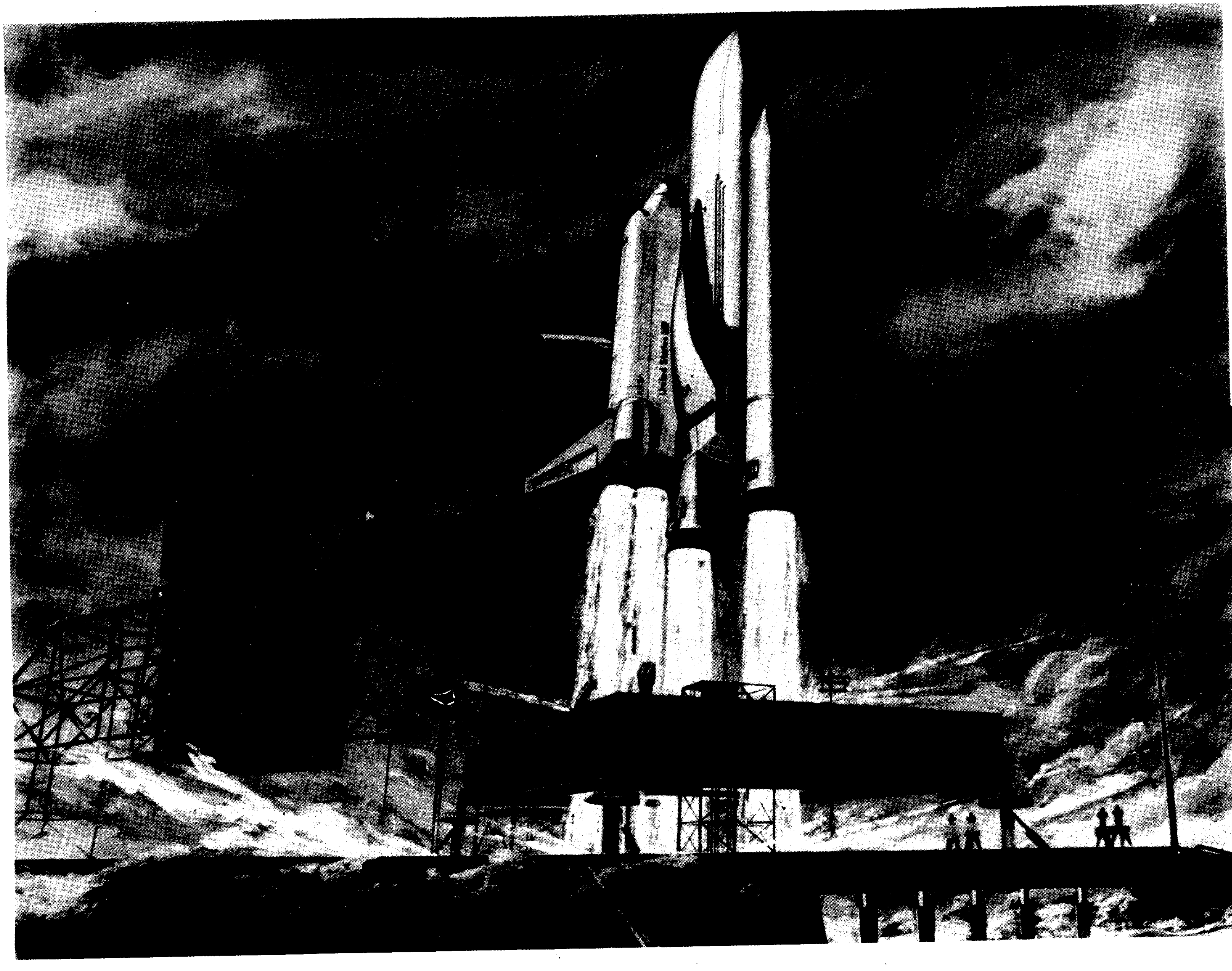
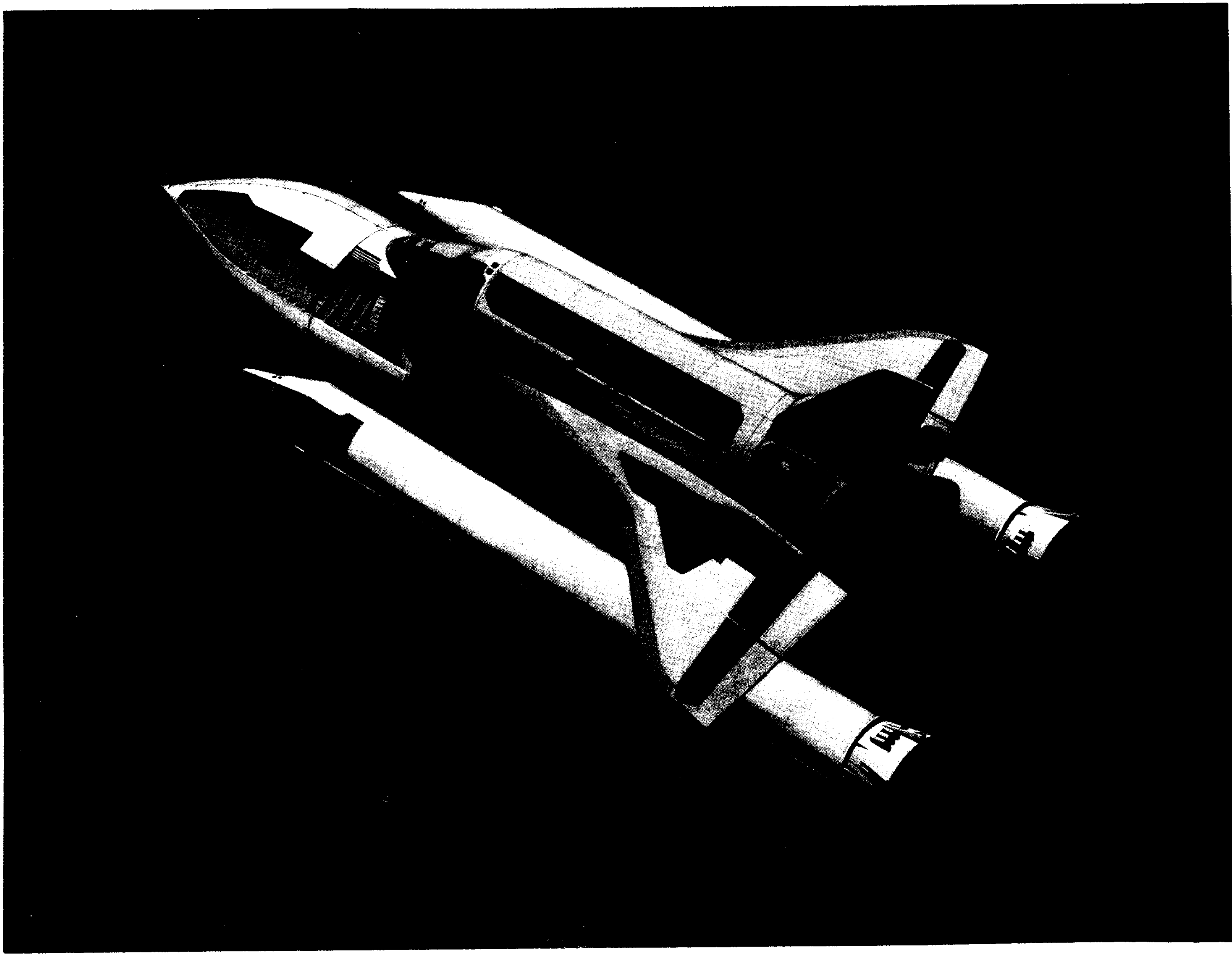
Enterprise was transferred from the Rockwell International assembly plant at Palmdale, Calif., to the Dryden Center Jan. 31. At completion of ALT, this first Orbiter will be ferried atop the SCA to NASA's Marshall Space Flight Center, Huntsville, Ala., where it will undergo extensive ground vibration tests. Subsequent to these tests it will return to the Rockwell facility at Palmdale and prepare for orbital flight sometime in the early 1980s.

The second Orbiter (102), currently under construction, will be the first vehicle to be used in the Shuttle Orbital Flight Test (OFT) program which is scheduled to begin in mid-1979. Six OFT flights are planned to demonstrate the Orbiter's capabilities in Earth orbit before the start of the Shuttle operational flights which are scheduled to begin in 1980.

(END OF GENERAL RELEASE. BACKGROUND INFORMATION FOLLOWS.)





SPACE TRANSPORTATION SYSTEM

The Space Transportation System of the next decade will consist of the Space Shuttle, Spacelab and upper stages to propel payloads beyond the capability of the Shuttle to synchronous orbit and to the planets.

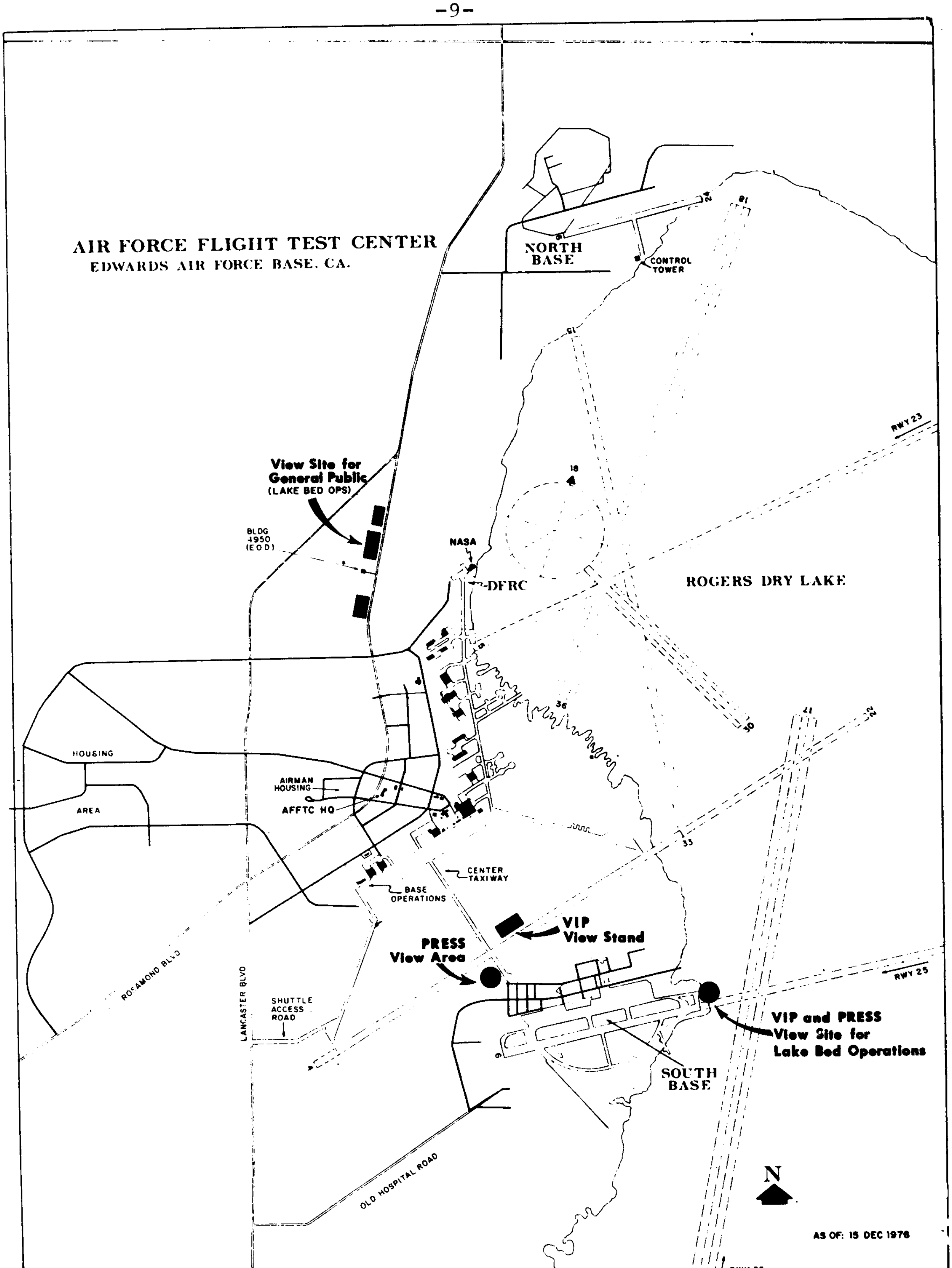
With the Space Shuttle, the rather large stable of launch vehicles that we use today -- both civilian and military -- will be greatly reduced. The Shuttle will be used to place almost all our satellites into orbit and, more importantly, it will have the capability to retrieve malfunctioning satellites and repair them in orbit or return them to Earth. This capability assumes particular importance with the predicted growing future requirements for additional weather, Earth resources, communication and navigational satellites. No longer will it be necessary to write off a multi-million-dollar satellite due to a malfunction following launch.

The Space Shuttle will be capabable of carrying the Spacelab into orbit. Spacelab, carried in the Shuttle cargo bay, provides a shirtsleeve, pressurized environment for scientific and technical investigators to work in space. Airlocks and a pallet external to the pressurized area will be available for experiments that require direct access to the space environment.

For lunar and planetary missions, the Shuttle will be capable of carrying upper stages into Earth orbit which will propel probes and satellites into outer space. These upper stages will also be used to place satellites into high geosynchronous orbits.

APPROACH AND LANDING TESTS

The Orbiter Approach and Landing Tests program is to verify subsonic airworthiness, pilot-guided and automatic landing capabilities of the Orbiter. These tests, which will be conducted at NASA's Dryden Flight Research Center, Edwards Air Force Base, Calif., will begin in February 1977, with a series of unmanned and manned flights mated on top of a modified 747 jetliner, the Shuttle Carrier Aircraft (SCA). (See ALT schedule.)


AIR FORCE FLIGHT TEST CENTER
EDWARDS AIR FORCE BASE, CA.
NORTH BASE
CONTROL TOWER
View Site for General Public (LAKE BED OPS)
BLDG 4950 (EOD)
NASA
DFRC
ROGERS DRY LAKE
RWY 23
HOUSING
AREA
AIRMAN HOUSING
AFFTC HQ
CENTER TAXIWAY
BASE OPERATIONS
VIP View Stand
PRESS View Area
ROSAMOND BLVD
LANCASTER BLVD
SHUTTLE ACCESS ROAD
RWY 25
VIP and PRESS View Site for Lake Bed Operations
SOUTH BASE
OLD HOSPITAL ROAD
N
AS OF: 15 DEC 1976
RWY 35

The first tests call for the 101 vehicle to be placed on top of the SCA for a number of taxi runs on the runway at Edwards. The taxi tests will be followed by six captive flights where the unmanned Orbiter will be carried to an altitude of approximately 7,600 m (25,000 ft.) by the SCA, but not released.

These unmanned captive flights will be followed by a series of captive flights with the ALT crew aboard the Orbiter. These tests are designed to verify most of the Orbiter's systems and crew procedures as well as provide some verification of Orbiter dynamics and controllability.

A series of manned free flights will be conducted beginning in July 1977. The Orbiter will be carried aloft, released from the 747 carrier and flown to an unpowered landing four to five minutes later on a dry lake bed landing strip at Edwards. The SCA, specifically modified for these test flights, will carry the Orbiter to an altitude of about 8,500 m (28,000 ft.). All dates, flight profiles, flight times and procedures are subject to change as the program progresses.

Taxi Test

The taxi tests will be conducted on Runway 04-22 at Edwards AFB. All taxi tests will be scheduled early in the morning to minimize problems associated with heat build-up in the tires and brake system.

The first run of the mated configuration (Orbiter/ Shuttle Carrier Aircraft) starts at the end of the runway with the vehicle traveling southwest to northeast. The test will be terminated when the airplane reaches a speed of 75 knots. After an inspection of the tires and brakes, the second test will begin with the airplane traveling up to a speed of 120 knots, when normal braking will be applied.

The final run will be performed at a maximum speed of 135 knots. Thrust reversers, in addition to normal braking and speed brakes, will be applied.

Captive Inert Flights

Six flights with an unmanned inert Orbiter are planned. These tests are concerned with verifying performance, stability and control, flutter margin and buffet characteristics of the mated configuration in flight patterns similar to the manned Orbiter free flights and to insure safe operation of the combined vehicle configuration.

The combined weight of the two vehicles, dependent upon flight requirements, will vary from about 265,350 kg (585,000 lb.) to about 285,770 kg (630,000 lb.). The inert Orbiter will weigh 68,000 kg (150,000 lb.).

Flights and primary objectives are as follows:

Flight 1 - Obtain evaluation of low speed performance and handling qualities.

Flight 2 - Interim evaluation of stability and control characteristics and completion of airspeed systems calibration.

Flight 3 - Complete basic flutter and stability testing, and explore minimum flying speed for heavy and light gross weight conditions at several 747 flap settings.

Flight 4 - Investigation of marginal operational characteristics and simulated engine-out conditions.

Flight 5 and 6 - These two flights will be similar, for the most part, with primary purpose of evaluating the performance and procedures associated with the launch attempt of the Orbiter from the 747. Maximum altitude and speed will be 7,620 m (25,000 ft.), and 509 km/hr (275 knots).

Captive Active Orbiter (Manned Testing)

Astronaut crews will be aboard the Orbiter during the six active captive flights which are designed to determine the optimum separation profile based on inert test results, refine and finalize Orbiter and SCA crew procedures and evaluate Orbiter integrated systems operations. Five of the flights will be with the Orbiter tailcone attached and the sixth with the tailcone off. The tailcone is an aerodynamic fairing to reduce buffeting on the 747 tail surfaces. Its use permits higher altitudes. It will be used on all 747-Orbiter ferry flights.

The captive active flights and their primary objectives are:

Flight 1 - The first manned Orbiter mated test will go to an altitude of 7,225 m (23,700 ft.) and fly three times around the "racetrack" course (approximately 67 by 24 km (40 by 14 mi.). The Orbiter crew will perform normal operational checks and systems operations. During this flight, low speed 435 km/hr (235 kts) and high speed 480 km/hr (260 kts) flutter checks will be performed to evaluate Orbiter structural dynamic response characteristics. On the inbound leg of the third circuit around the racetrack, a pushover and separation trajectory will be flown at 480 km/hr (260 kts) to collect separation performance data.

Flight 2 - This flight is dedicated to the verification of the separation conditions and tolerances, as well as checks of the Orbiter's avionics systems and further procedures development. As in the first flight, the 747 will fly three times around the racetrack trajectory. On the inbound leg of the second circuit around the racetrack, a pushover and separation trajectory will be flown at 500 km/hr (270 kts) to collect separation performance data. During final descent, the SCA/Orbiter mated configuration will fly through the autoland trajectory.

Flights 3-5 - The third, fourth and fifth flights are dedicated to further refinement and demonstration of separation procedures (short of actual release), separation abort techniques, chase aircraft operations and performances of avionics tests.

After the fifth manned captive flight with the tailcone on, the first of five free flights with tailcone on are planned. These will be followed by the sixth manned captive flight with the tailcone off.

Flight 6 - Purpose of this flight is to demonstrate the separation performance and flight worthiness of the Orbiter and 747 in a tailcone off configuration. Orbiter and 747 crews will go through the preseparation procedures as will be performed in the free flight , short of separation.

Based on the 747 buffeting experience with the tailcone off on flight 6, a decision will be made whether to proceed with the sixth, seventh and eighth free flights with tailcone off.

Free Flights - ALT

A series of up to eight free flights are scheduled to follow the manned captive flights at Dryden Center. The free flights are designed to verify Orbiter subsonic airworthiness, integrated system operations and pilot-guided approach and landing capability and satisfying prerequisites to automatic flight control and navigation mode. The first five free flights will be flown with tailcone on.

The tailcone on flights will generally follow this pattern:

The flight path of the Orbiter and 747 follows a race-track pattern with separation occurring when the vehicles are about 13 km (8 mi.) to the right and flying parallel to the landing runway. From the separation point, the Orbiter will fly a U-shaped ground track to the runway.

To perform the separation maneuver, the 747 will pitch down to -6 degrees and accelerate to establish equilibrium glide conditions of 270 knots equivalent air speed (KEAS) and -9.2 degrees flight path angle. At this point, the Orbiter pilot will initiate separation by arming and firing a series of explosive bolts at an altitude of about 6,700 m (22,000 ft.) above runway level.

At separation, the Orbiter pilot will command a pitch up maneuver which will provide a vertical separation of more than 60 m (200 ft.) in about five seconds. The 747 will turn left while the Orbiter turns right to provide horizontal separation. The Orbiter crew will then perform a series of test maneuvers to obtain data on the Orbiter aerodynamics, flight control and systems operation. On the first flight the Orbiter will pitch down, accelerate to 270 KEAS and then perform a practice landing (at 18,000 ft. altitude), allowing the airspeed to decrease to 185 KEAS while evaluating the flying qualities of the Orbiter.

The Orbiter pilot will then pitch down to accelerate and, at the same time, initiate the first of two 90-degree turns to the left which will align it with a lakebed runway.

At the completion of the second turn, the Orbiter is aligned with the runway at an altitude of 1,980 m (6,500 ft.) and about 14 km (9 mi.) from the touchdown point, speed 270 KEAS, flight path -9 degrees.

First flare (preflare) starts at an altitude of 270 m (900 ft.), and transfers to the Orbiter from the -9 degree glide slope to a -1.5 degree glide slope. The landing gear is deployed shortly afterward, at about 105 m (350 ft.) altitude and the landing flare (final flare) is initiated at slightly less than 30 m (100 ft.) altitude. The final flare establishes a sink rate of approximately 3 feet per second which is held to touchdown. Touchdown airspeed is about 180 KEAS and elapsed time from separation to touchdown is about 5 minutes, 15 seconds.

Because of the increased drag when the streamlined Orbiter tailcone is removed, the maximum altitude the 747 can achieve and the distance the Orbiter can glide after release, are reduced. Thus, for tailcone off flights, the Orbiter will be launched at an altitude of 5,400 to 5,600 m (17,700 to 18,300 ft.) above runway level and 19.3 km (12 mi.) from the end of the runway. Launch and separation procedures will be the same as for the tailcone on flights, but the Orbiter will fly a "straight in" approach to the runway instead of the U-shaped ground track flown with tailcone on.

Approach speed will be 290 KEAS, flight path -24 degrees and preflare will start at an altitude of 600 m (2,000 ft.). Landing gear deployment, final flare and landing will be similar to tailcone on flights. Flight time from release to landing will be two and a half minutes or less.

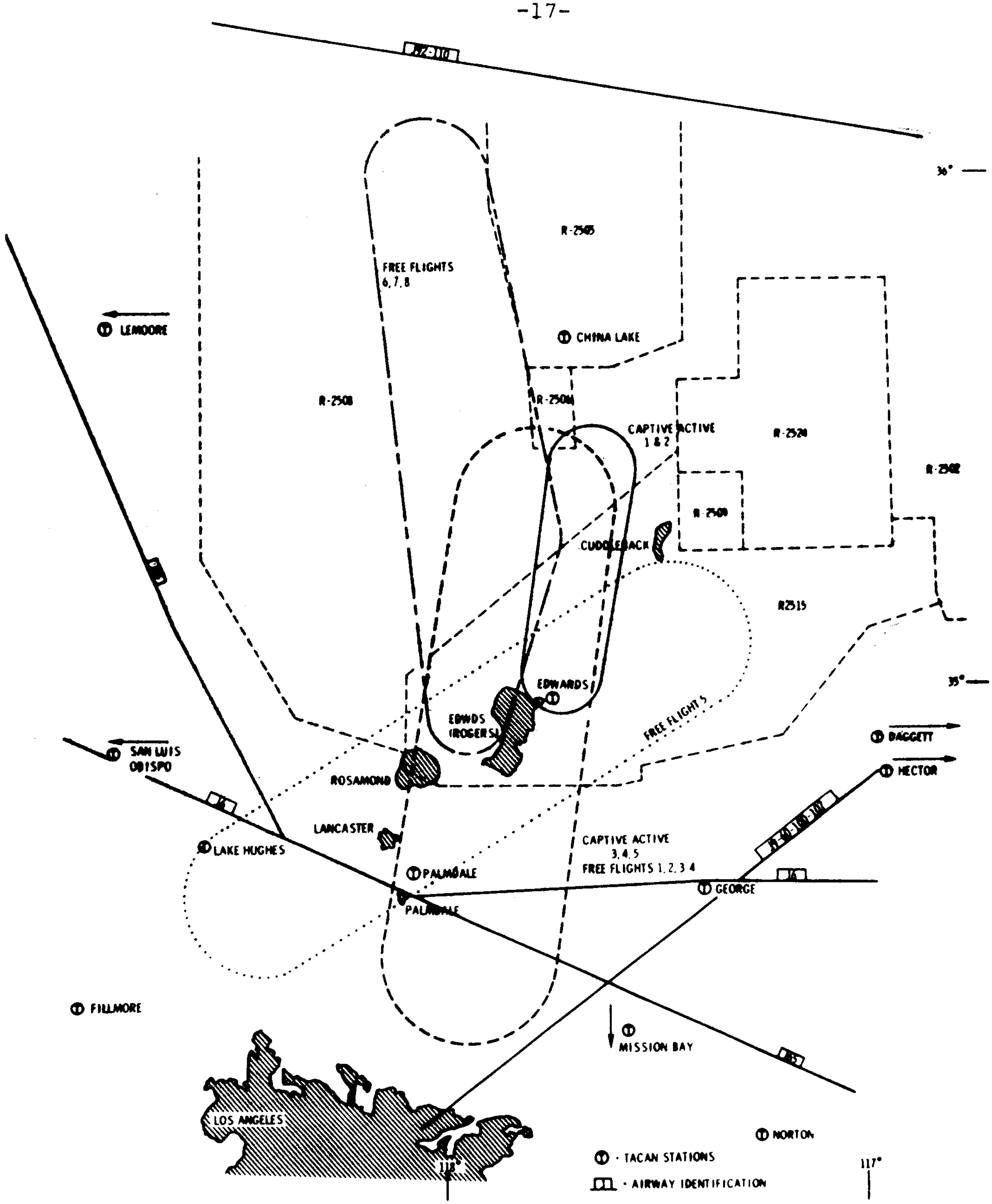
FREE FLIGHT PLAN

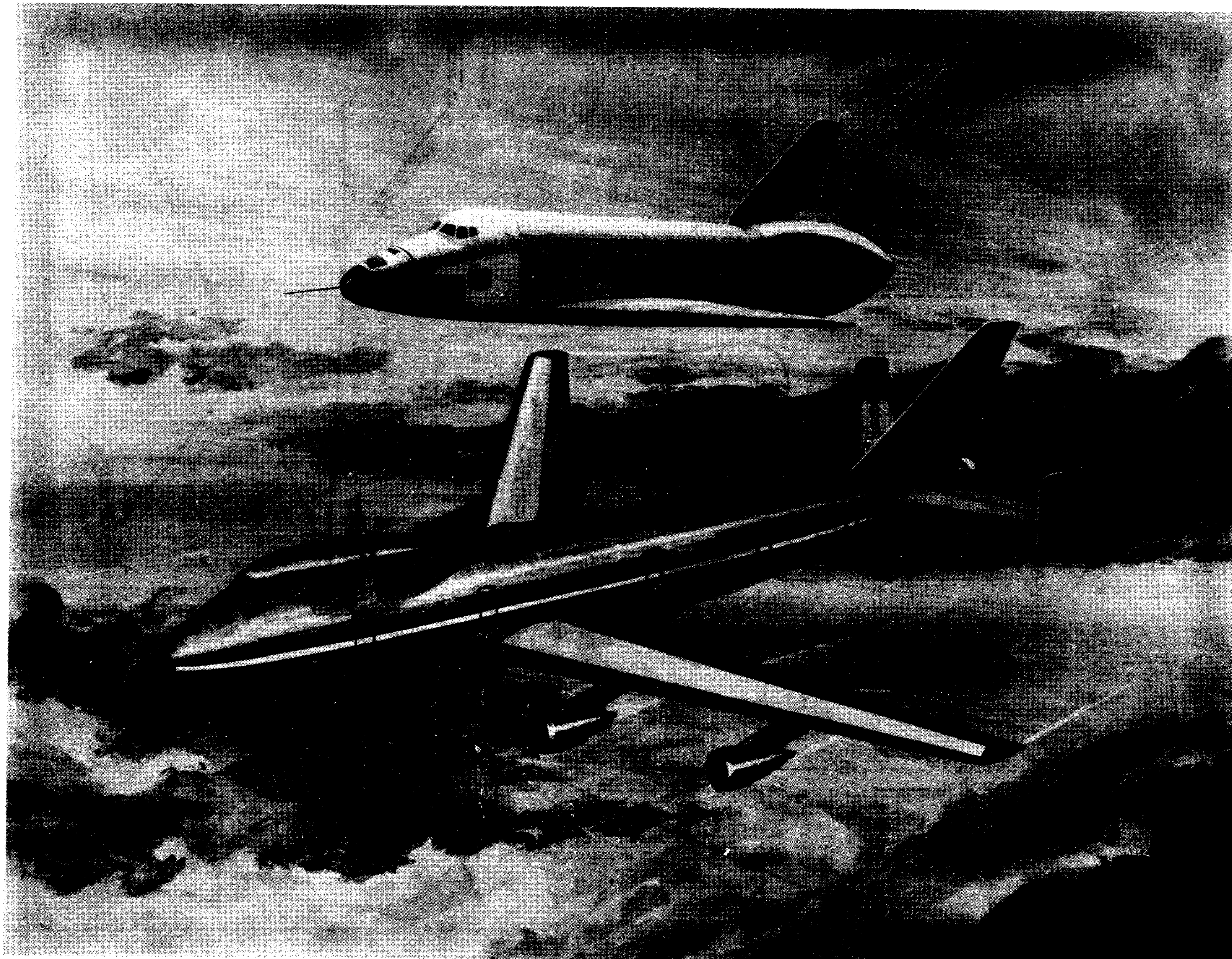
Flight	Configuration	Description	Major Objectives
1	Tailcone on	Practice flare at altitude 180 degree turn Lake bed landing	Manual landing Handling qualities Gentle braking Nose wheel steering
2	Tailcone on	Test inputs at 300 kts 1.8g turn Test inputs at 200 kts 45-degree speed brake with inputs Lake bed landing	Test inputs for high speed, low speed and with speed brake Turn maneuverability Nose wheel steering
3	Tailcone on	Test inputs at 300 kts 1.8g turn Test inputs at 200 kts 35-degree speed brake with inputs Lake bed landing	Test inputs for high speed, low speed and with speed brake Turn maneuverability Nose wheel steering
4	Tailcone on	FCS* mode switching Manual direct FCS 180-degree turn Auto FCS Closed loop auto guidance to above preflare altitude Lake bed landing	Verify FCS modes and switching Auto guidance Steering with differential braking
5	Tailcone on	180-degree side approach to concrete landing 45 degree speed brake	Concrete landing Braking on paved surface Autoland information

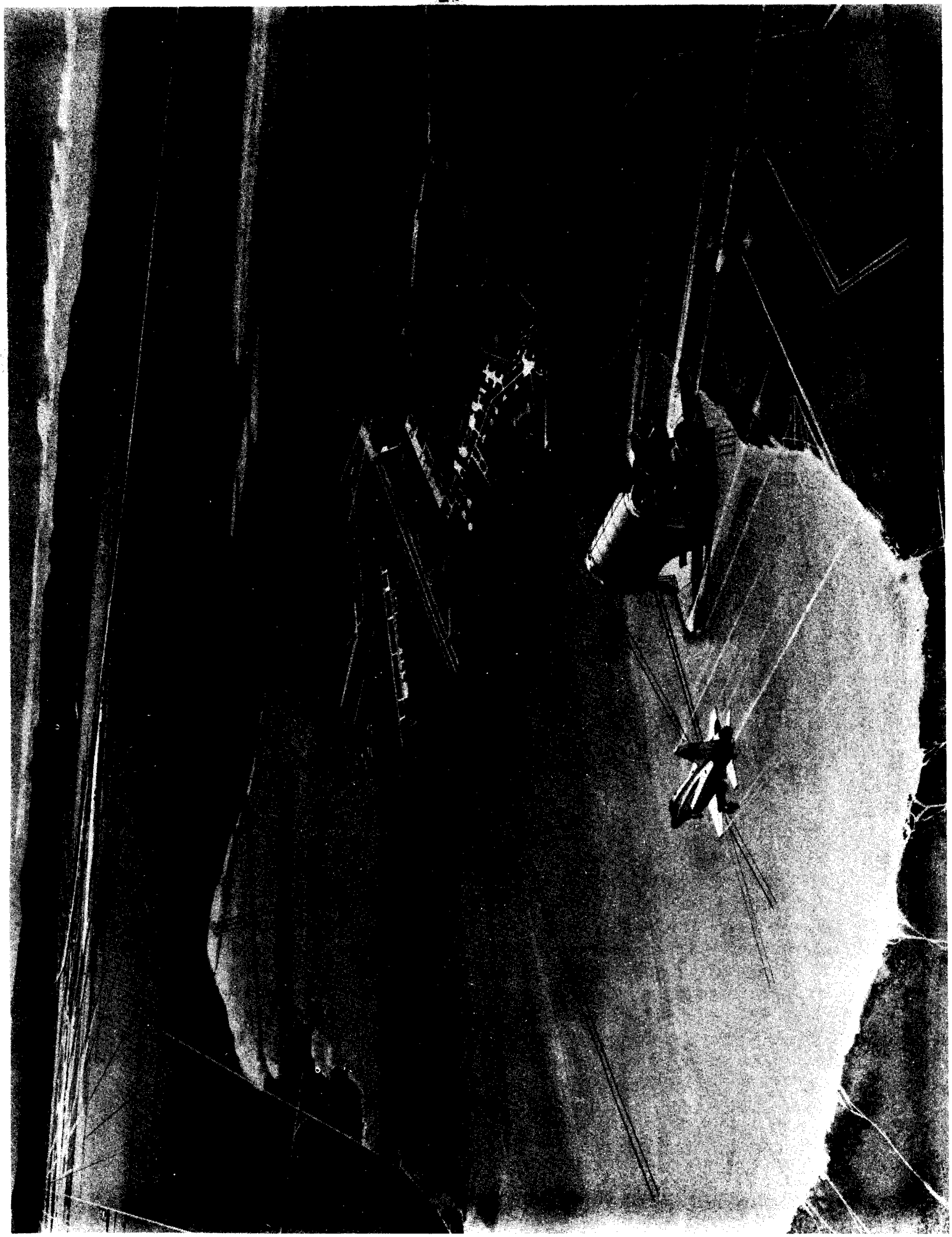
Before commitment to the sixth free flight, a high-speed tailcone-off taxi test will be performed. If this is satisfactory, the sixth captive manned tailcone off flight will be performed. Based on the buffeting experienced, a decision will be made to proceed with the sixth, seventh and eighth free flights with tailcone off.

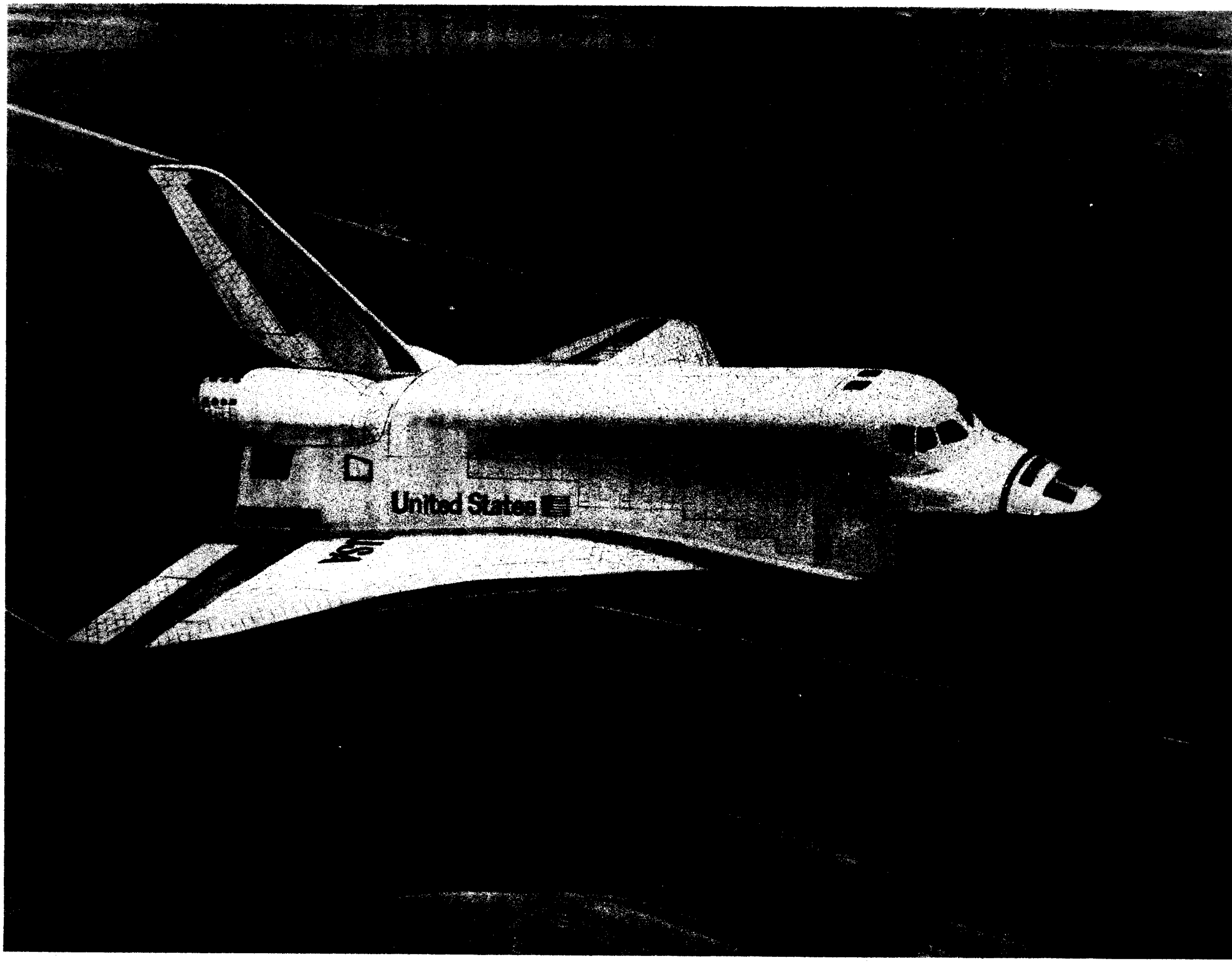
* FCS - Flight Control Subsystem

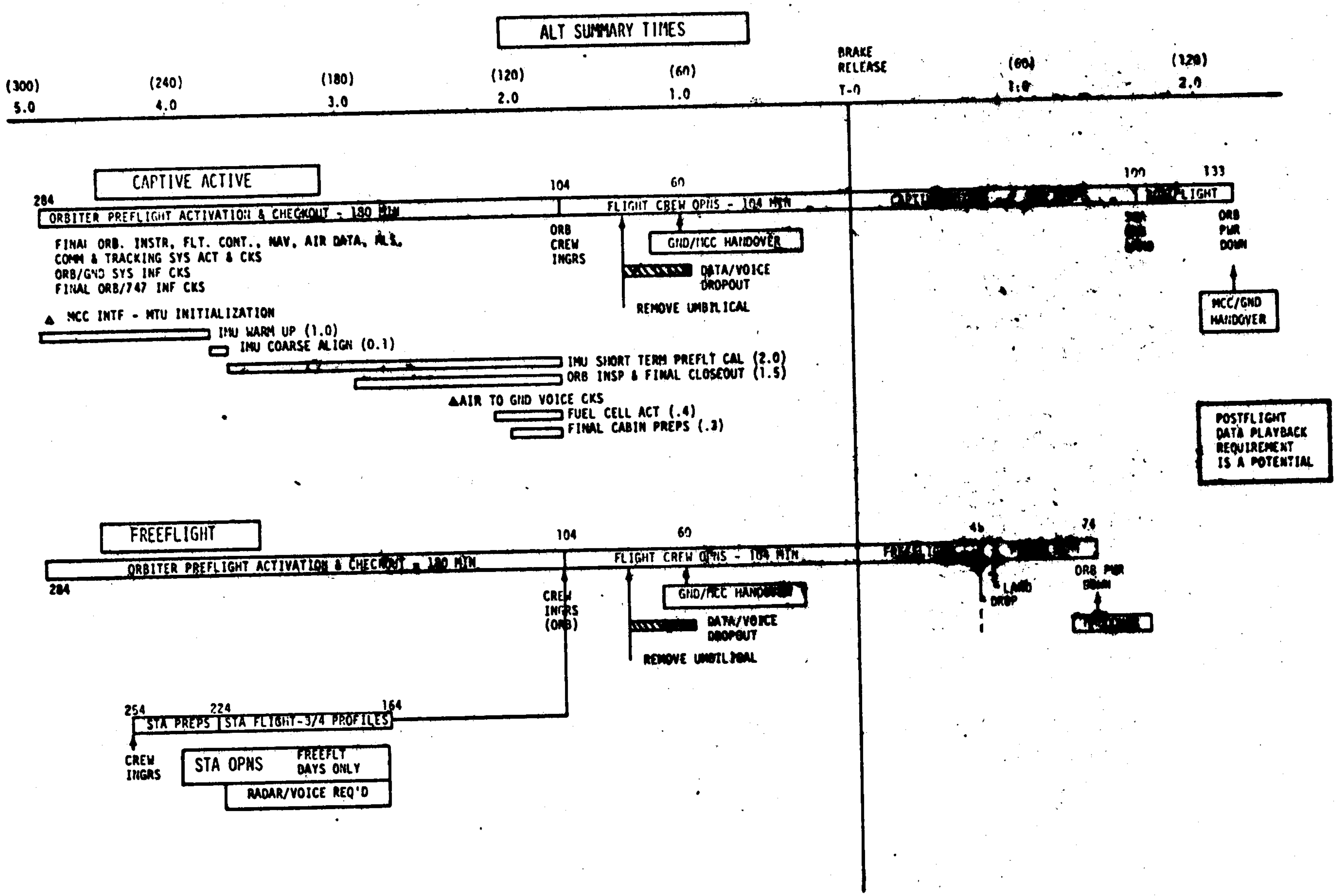
Flight	Configuration	Description	Major Objectives
6	Tailcone off	Practice flare at altitude	Manual landing Handling qualities
7	Tailcone off	Auto FCS 45-degree speed brake Closed loop auto guidance to above preflare altitude Speed brake retraction Lake bed landing	Auto guidance Speed brake modulation
8	Tailcone off	Closed loop auto guidance and speed brake modulation to touchdown Lake bed landing	Auto guidance Auto landing


R-2505
FREE FLIGHTS
6, 7, 8
LEMOORE
CHINA LAKE
R-2508
R-2524
CAPTIVE ACTIVE
1 & 2
R-2502
R-2509
CUDDLEBACK
R2515
EDWARDS
EDWDS
(ROGERS)
FREE FLIGHT 5
DAGGETT
HECTOR
SAN LUIS
OBISPO
ROSAMOND
LANCASTER
LAKE HUGHES
CAPTIVE ACTIVE
3, 4, 5
FREE FLIGHTS 1, 2, 3, 4
PALMDALE
GEORGE
FILLMORE
MISSION BAY
LOS ANGELES
NORTON
118°
117°
36°
35°
- TACAN STATIONS
- AIRWAY IDENTIFICATION






United States

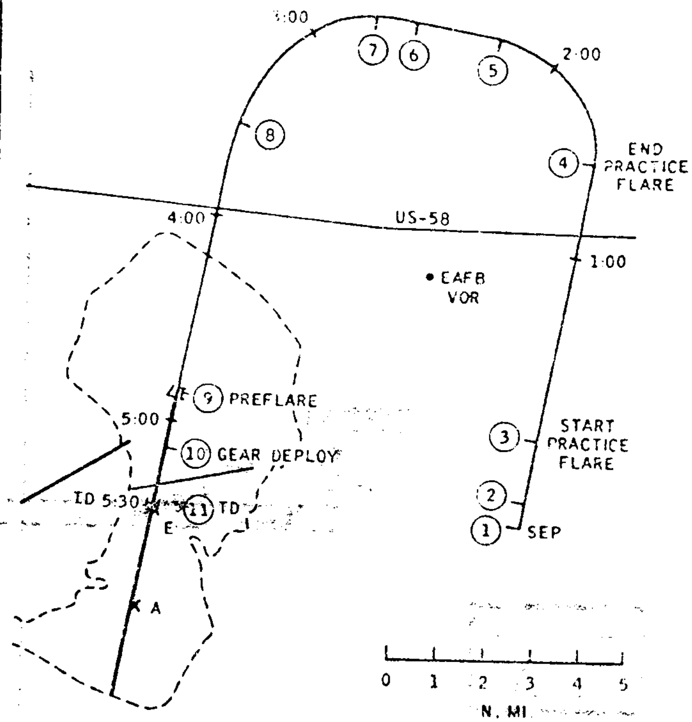


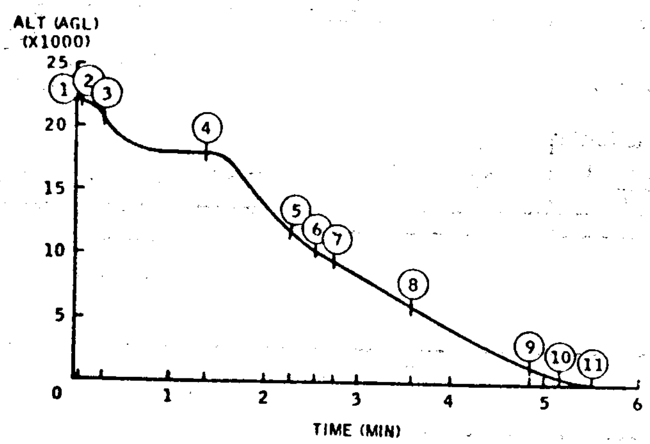
ALT SUMMARY TIMES
BRAKE RELEASE
T-0
(300) 5.0
(240) 4.0
(180) 3.0
(120) 2.0
(60) 1.0
(60) 1.0
(120) 2.0
CAPTIVE ACTIVE
284
104
60
100
133
ORBITER PREFLIGHT ACTIVATION & CHECKOUT - 180 MIN
FLIGHT CREW OPNS - 104 MIN
ORB CREW INGRS
GND/MCC HANDOVER
DATA/VOICE DROPOUT
REMOVE UMBILICAL
ORB PWR DOWN
MCC/GND HANDOVER
FINAL ORB. INSTR, FLT. CONT., NAV, AIR DATA, ALS,
COMM & TRACKING SYS ACT & CKS
ORB/GND SYS INF CKS
FINAL ORB/747 INF CKS
▲ MCC INTF - MTU INITIALIZATION
IMU WARM UP (1.0)
IMU COARSE ALIGN (0.1)
IMU SHORT TERM PREFLT CAL (2.0)
ORB INSP & FINAL CLOSEOUT (1.5)
▲AIR TO GND VOICE CKS
FUEL CELL ACT (.4)
FINAL CABIN PREPS (.3)
POSTFLIGHT DATA PLAYBACK REQUIREMENT IS A POTENTIAL
FREEFLIGHT
104
60
46
74
ORBITER PREFLIGHT ACTIVATION & CHECKOUT - 180 MIN
FLIGHT CREW OPNS - 104 MIN
284
CREW INGRS (ORB)
GND/MCC HANDOVER
DATA/VOICE DROPOUT
REMOVE UMBILICAL
LAND DROP
ORB PWR DOWN
254
224
164
STA PREPS
STA FLIGHT-3/4 PROFILES
CREW INGRS
STA OPNS
FREEFLT DAYS ONLY
RADAR/VOICE REQ'D

SECTION 5.6

ALT FREE FLIGHT 1

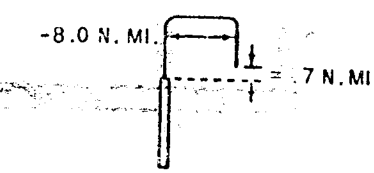
ITEM	TIME	ALT (AGL)	KEAS	α	θ	ACTION
1	0:00	22100	260	10	.5	SEP; $\dot{\theta}$ = 2°/SEC, 3 SEC; $\dot{\theta}$ = 0, 2 SEC
2	0:05	21900	250	7	6.5	ROLL RIGHT ϕ = 20°; $\dot{\theta}$ = -1°/SEC AT θ = -5° ROLL ϕ = 0; CONTINUE $\dot{\theta}$ = -1°/SEC TO θ = -10
3	0:18	20400	270	6	-10	AT AS = 270 INITIATE PRACTICE FLARE $\dot{\theta}$ = 2°/SEC; CONTINUE FLARE TO HOLD $\dot{h}$ = 0, AS = 185
4	1:25	17900	185	11	11	AT AS = 185 $\dot{\theta}$ = -1°/SEC TO θ = -6°; ROLL LEFT TO ϕ = 30°
5	2:15	12000	240	8	-6	AT ψ = 265° ROLL TO ϕ = 0
6	2:35	10000	265	6	-6	AT AS = 265 $\dot{\theta}$ = 1°/SEC TO θ = -2 TO HOLD AS = 270
7	2:45	9300	270	5	-2	ROLL LEFT TO ϕ = 30° TO LINE UP ON RUNWAY ψ = 175°
8	3:35	6000	270	5	-2	TURN COMPLETE HOLD AS = 270
9	4:55	900	270	5	-2	INITIATE PREFLARE
10	5:10	350	250	6	4	AT AS = 250, DEPLOY GEAR
11	5:30	0	175	11	11	T.D. AS < 220; $\dot{h}$ < 10 fps
12	5:45	0	100	--	--	AT AS = 100, GENTLE BRAKING TO AS = 80
13	6:00	0	50	--	--	AT AS = 50, ENGAGE NWS





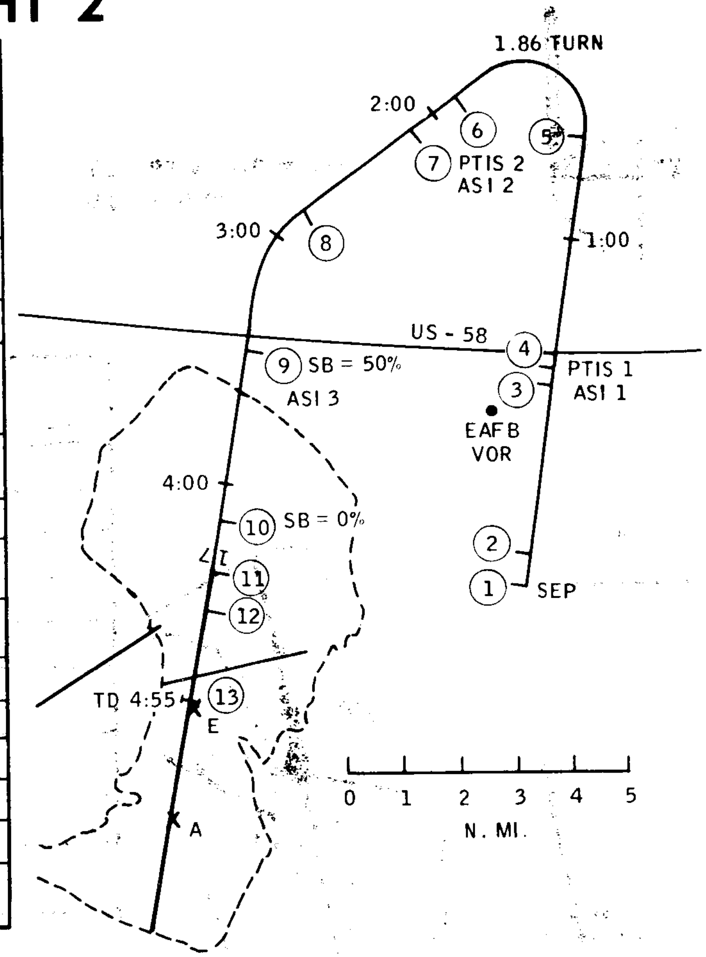
WT = 150,000

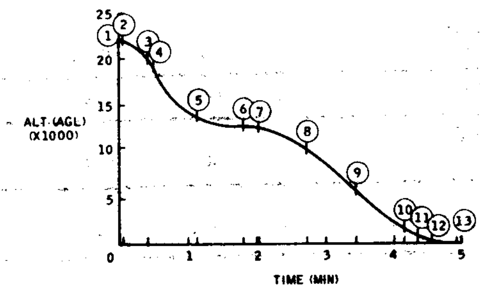
CG = 64.5 % (1070.24)

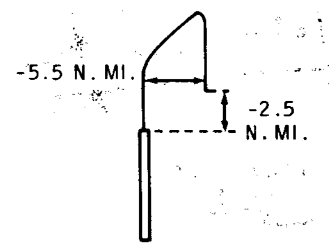


ALT FREE FLIGHT 2

ITEM	TIME	ALT (AGL)	KEAS	α	θ	ACTION
1	0:00	22100	260	10	.5	SEP; $\dot{\theta}$ = 2°/SEC, 3 SEC; $\dot{\theta}$ = 0, 2 SEC
2	0:05	21900	250	7	6.5	ROLL RIGHT ϕ = 20°; $\dot{\theta}$ = -1°/SEC AT θ = -5° ROLL ϕ = 0; CONTINUE $\dot{\theta}$ = -1°/SEC TO θ = -10
3	0:33	18200	295	5	-10	$\dot{\theta}$ = 2°/SEC TO θ = -3° TO HOLD AS = 300
4	0:35	17600	300	5	-3	PTIS; STICK INPUTS (TOTAL 35 SEC)
5	1:10	13600	300	5	-3	$\dot{\theta}$ = 1°/SEC TO θ = 3; ROLL LEFT 55°; HOLD N_z = 1.8g (α < 13°) TURN TO ψ = 220°
6	1:50	12400	230	9	10	ϕ = 0; $\dot{\theta}$ = -1°/SEC TO θ = 2 HOLD AS = 200
7	2:05	12200	200	9	2	PTIS; STICK INPUTS (35 SEC)
8	2:40	10300	200	9	2	ROLL LEFT ϕ = 30°; $\dot{\theta}$ = -1°/SEC TO θ = -9° TURN TO ψ 175°
9	3:28	5500	260	5	-9	$\dot{\theta}$ = 1°/SEC TO θ = -7°; SB = 50% HOLD AS = 270; STICK INPUTS (15 SEC)
10	4:08	2000	270	5	-7	SB → 0
11	4:20	900	270	5	-7	INITIATE PREFLARE
12	4:35	350	250	6	4	AT AS = 250, DEPLOY GEAR
13	4:55	0	175	11	11	T.D. AS < 220; $\dot{h}$ < 10 fps
14	5:10	0	90	--	--	AT AS = 90, ENGAGE NWS
15	5:25	0	60	--	--	LOW TO MODERATE BRAKING AS REQUIRED WHEN AS < 60





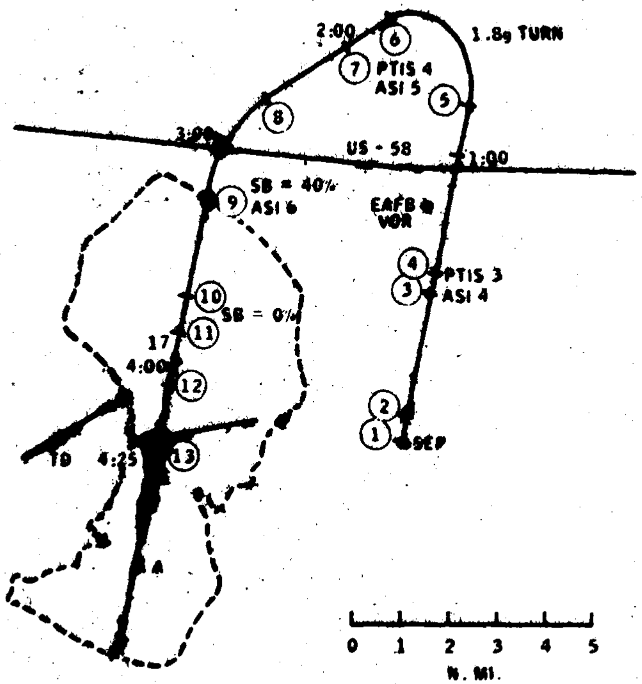


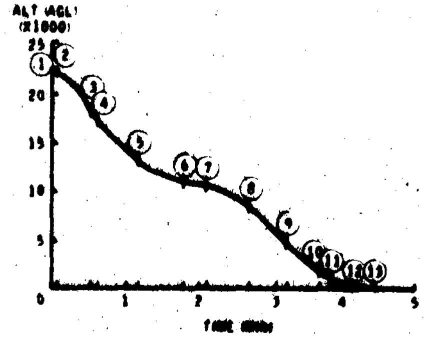
WT = 150,000
CG = 64.4% (1070.24)

-more-

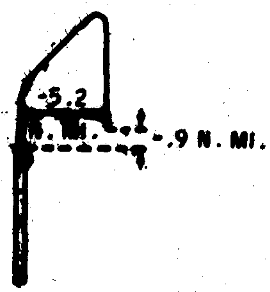
ALT FREE FLIGHT 3

ITEM	TIME	ALT (AGL)	KEAS	α	θ	ACTION
1	0:00	22100	260	10	.5	SEP; $\dot{\theta}$ = 2°/SEC, 3 SEC; $\dot{\theta}$ = 0, 2 SEC
2	0:05	21900	250	7	6.5	ROLL RIGHT ϕ = 20°; $\dot{\theta}$ = -1°/SEC AT θ = -5° ROLL ϕ = 0; CONTINUE $\dot{\theta}$ = -1°/SEC TO θ = -10°; BF = 0
3	0:33	17700	295	5	-10	$\dot{\theta}$ = 2° SEC TO θ = -5 TO HOLD AS = 300
4	0:35	17000	300	5	-5	PTIS; STICK INPUTS (TOTAL 35 SEC)
5	1:10	13100	300	5	-5	$\dot{\theta}$ = 1°/SEC TO θ = 3; ROLL LEFT 55°; HOLD N_z = 1.8g (α < 13°) TURN TO ψ = 220°
6	1:50	10900	230	9	10	ϕ = 0; $\dot{\theta}$ = -1°/SEC TO θ = 2 HOLD AS = 200
7	2:05	10700	200	9	2	PTIS; STICK INPUTS (35 SEC)
8	2:40	8500	200	9	2	ROLL LEFT ϕ = 30°; $\dot{\theta}$ = -1°/SEC TO θ = -9° TURN TO ψ = 175°
9	3:14	4600	260	5	-9	$\dot{\theta}$ = 1°/SEC TO θ = -7°; SB = 40% HOLD AS = 270; STICK INPUTS (15 SEC)
10	3:38	2000	270	5	-7	SB → 0; BF → -11.7
11	3:50	900	270	5	-7	INITIATE PREFLARE
12	4:05	350	250	6	4	AT AS = 250, DEPLOY GEAR
13	4:25	0	175	11	11	T. D. AS < 229; $\dot{h}$ < 10 fps
14	4:35	0	115	--	--	AT AS = 115 ENGAGE NWS
15	4:55					MODERATE TO HARD BREAKING AS REQUIRED WHEN AS < 60





WT = 150,000
CG = 66.5% (1096.05)



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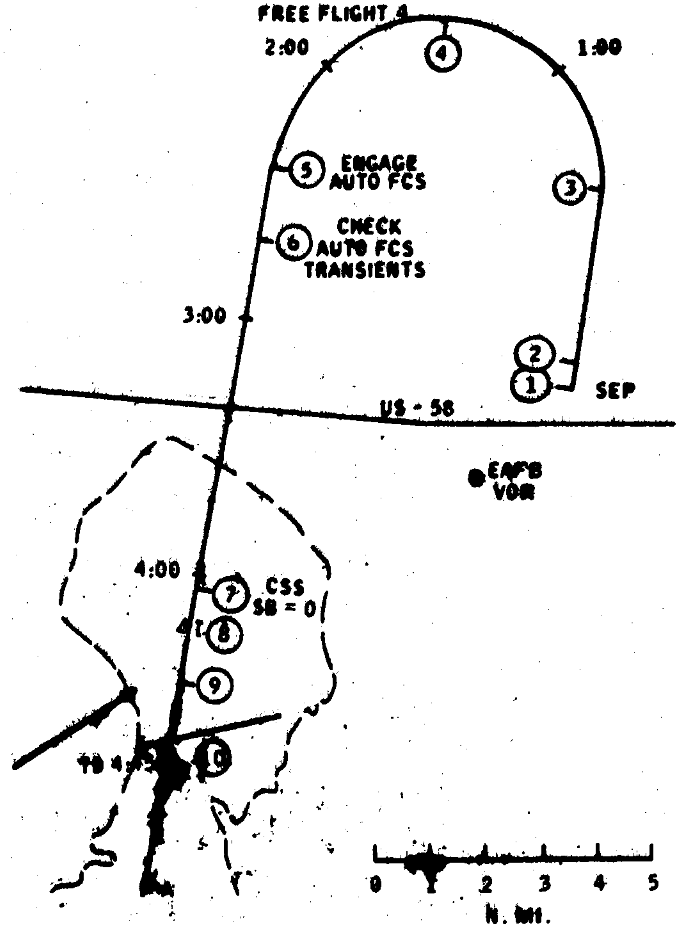
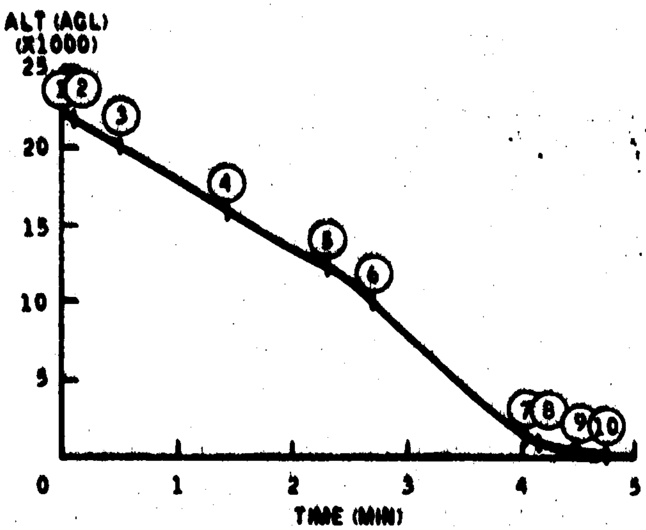
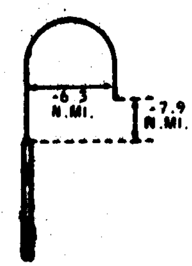
ALT FREE FLIGHT 4

ITEM	TIME	ALT (AGL)	KEAS	α	θ	ACTION
1	0:00	22100	280	10	.5	SEP; $\dot{\theta}$ = 2°/SEC, 3 SEC; $\dot{\theta}$ = 0, 2 SEC
2	0:05	21900	250	7	6.5	ROLL RIGHT ϕ = 20°; $\dot{\theta}$ = -1°/SEC TO θ = 0°, ROLL ϕ = 0.
3	0:30	20100	250	7	0	ROLL LEFT ϕ = 30°; HOLD AS = 250
4	1:25	16000	250	7	0	STEER VEHICLE TO LINE UP ON LOCALIZER (ψ = 175) AND GLIDE-SLOPE (θ = -5) WHEN ψ < 225° FLY GUIDANCE ERROR NEEDLES AND SPEEDBRAKE COMMANDS
5	2:20	12100	250	7	-5	WHEN THE GUIDANCE NEEDLES ARE CENTERED ENGAGE AUTO FCS AND SB
6	2:42	10000	270	6	-5	MONITOR AUTO GUIDANCE AND DISENGAGE AND ENGAGE
7	3:58	2000	270	6	-5	FCS → CSS; SB → 0
8	4:10	900	270	6	-5	INITIATE PREFLARE
9	4:25	350	250	6	5	AT AS = 250, DEPLOY GEAR
10	4:45	0	175	11	11	T.D. AS < 220; $\dot{h}$ < 10 fps
11	5:20	0	50	--	--	AT AS < 50, MAKE 6° HEADING CHANGES WITH DIFFERENTIAL BRAKING





WT = 150,000
CG = 64.5 % (1070.24)
BF = -11.7 ENTIRE FLIGHT
AUTO GUIDANCE GS = -12°



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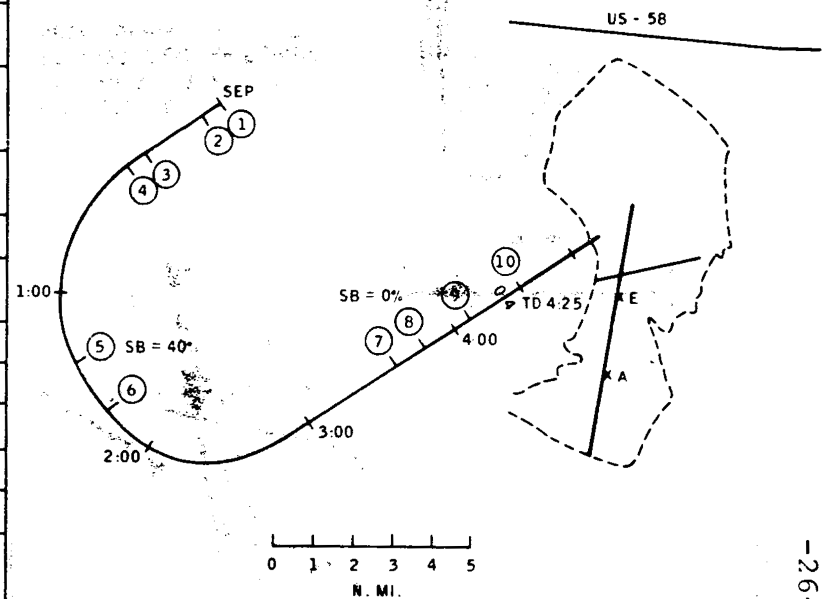
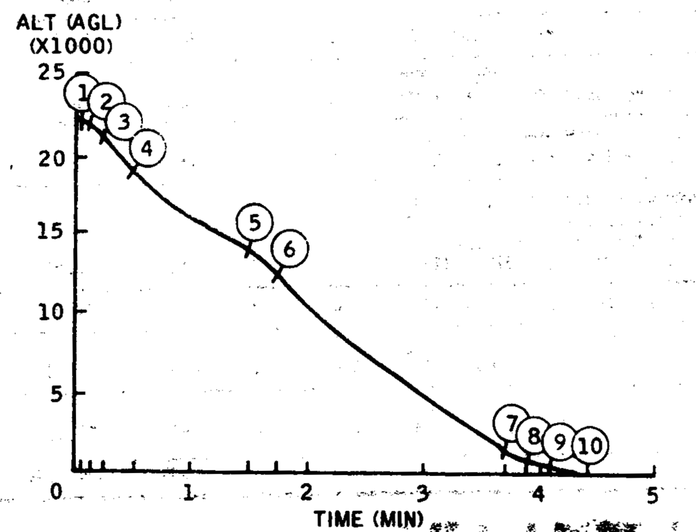
ALT FREE FLIGHT 5

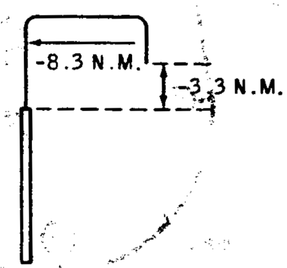
ITEM	TIME	ALT (AGL)	KEAS	α	θ	ACTION
1	0:00	22100	260	10	.5	SEP [illegible] 2°/SEC, 3 SEC; $\dot{\theta}$ = 0, 2 SEC
2	0:05	21900	250	7	6.5	ROLL RIGHT ϕ = 20°; $\dot{\theta}$ = -1°/SEC AT θ = -5° ROLL ϕ = 0; CONTINUE $\dot{\theta}$ = -1°/SEC TO θ = -10°
3	0:18	20400	270	6	-10	AS = 265 $\dot{\theta}$ = 2°/SEC TO θ = -2 HOLD AS = 270
4	0:28	18900	270	6	-2	ROLL LEFT ϕ = 30°; HOLD AS = 270
5	1:28	14000	270	6	-2	AT ψ = 235° ROLL ϕ = 0° SB → 40% θ → -4 HOLD AS = 270
6	1:43	12600	270	6	-4	ROLL LEFT ϕ = 30 TO ψ = 045°
7	3:38	2000	270	6	-4	SB → 0
8	3:50	900	270	5	-9	INITIATE PREFLARE
9	4:05	350	250	6	4	AT AS = 250, DEPLOY GEAR
10	4:25	0	175	11	11	TD AS < 220; $\dot{h}$ < 10 fps
11	4:28	0	160	--	--	AT TD + 3 SEC, BRAKE HARD 5 SEC WAIT 5 SEC, BRAKE HARD 5 SEC WAIT 5 SEC
12	4:48	0	--	--	--	BRAKE AS REQUIRED





WT = 150,000

CG = 64.5% (1070.24)



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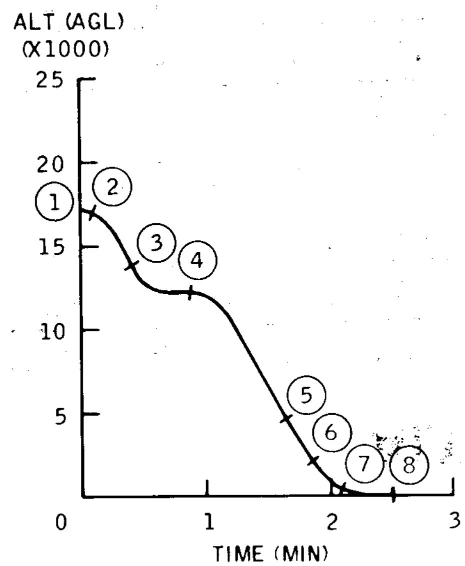
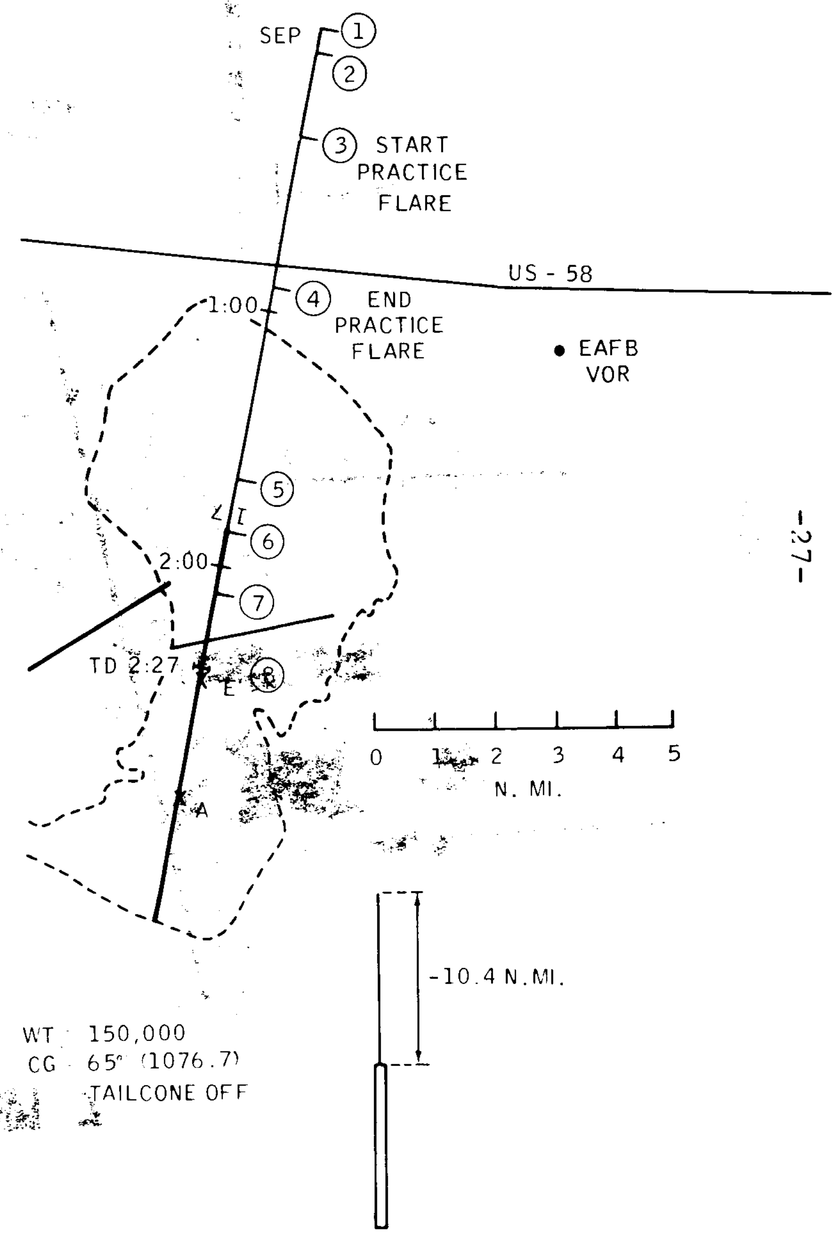
ALT FREE FLIGHT 6

ITEM	TIME	ALT (AGL)	KEAS	α	θ	ACTION
1	0:00	17200	260	10	.5	SEP; = 2°/SEC, 3 SEC; = 0, 2 SEC
2	0:05	17000	244	8	6.5	ROLL RIGHT = 20°; = -2°/SEC AT = -5° ROLL = 0; CONTINUE = -2°/SEC TO = -22°
3	0:23	14300	255	5	-22	AT AS = 255 INITIATE PRACTICE FLARE = 2°/SEC, CONTINUE FLARE TO HOLD $\dot{h}$ = 0; AS = 185
4	0:55	12200	185	11	11	AT AS = 185; = -2°/SEC TO = -22°
5	1:40	4600	285	4	-22	AT AS = 285 = 1°/SEC TO = -17° TO HOLD AS = 290
6	1:52	2000	290	4	-17	INITIATE PREFLARE = 2°/SEC
7	2:07	350	250	6	3	AT AS = 250 DEPLOY GEAR
8	2:27	0	175	11	11	T.D. AS 220; $\dot{h}$ 10 fps
9	2:30	0	160	--	--	BRAKE AS REQUIRED

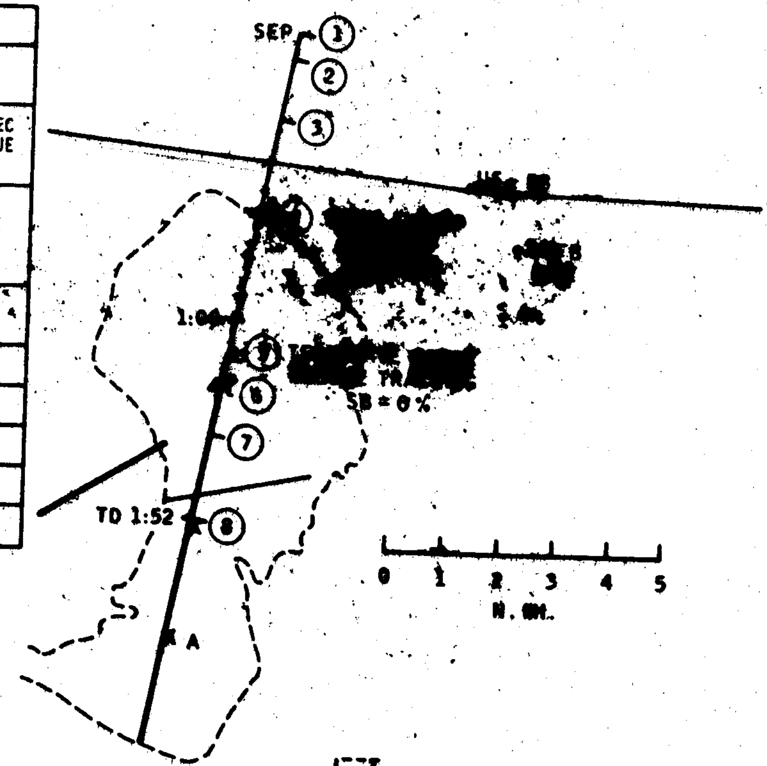


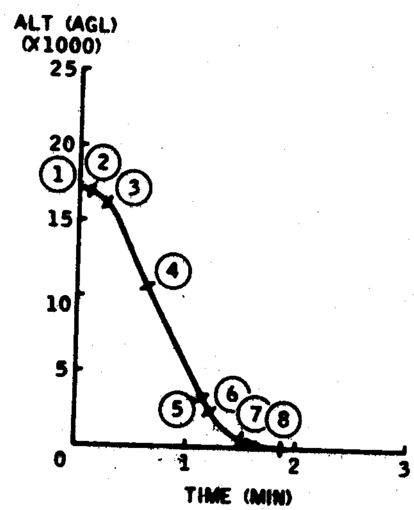


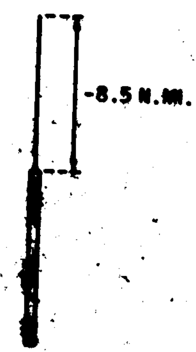
WT 150,000
CG 65° (1076.7)
TAILCONE OFF

ALT FREE FLIGHT 7

ITEM	TIME	ALT (AGL)	KEAS	α	θ	ACTION
1	0:00	17200	250	10	.5	SEP; $\dot{\theta}$ = 2°/SEC, 3 SEC; $\dot{\theta}$ = 0, 2 SEC
2	0:05	17000	244	7	6.5	ROLL RIGHT ϕ = 20°; $\dot{\theta}$ = -2°/SEC AT θ = -5° ROLL ϕ = 0; CONTINUE $\dot{\theta}$ = -2°/SEC TO θ = -22°
3	0:18	15500	228	5	-22	$\dot{\theta}$ = 0; ACCELERATE TO 290, FLY GUIDANCE ERROR NEEDLES TO LINE UP ON LOCALIZER (ψ = 175) AND GLIDESLOPE (θ = -20.5)
4	0:38	10400	290	4	-20.5	FLY GUIDANCE ERROR NEEDLES AND SB BRAKE COMMANDS ≈ 35%
5	1:10	3100	290	4	-20.5	SB → 0
6	1:15	2000	290	4	-20.5	INITIATE PREFLARE $\dot{\theta}$ = 2°/SEC
7	1:30	500	250	6	3	AT AS = 250, DEPLOY GEAR
8	1:52	0	175	11	11	TD AS < 220; $\dot{h}$ < 10 fps
9	1:55	0	160	--	--	BRAKE AS REQUIRED





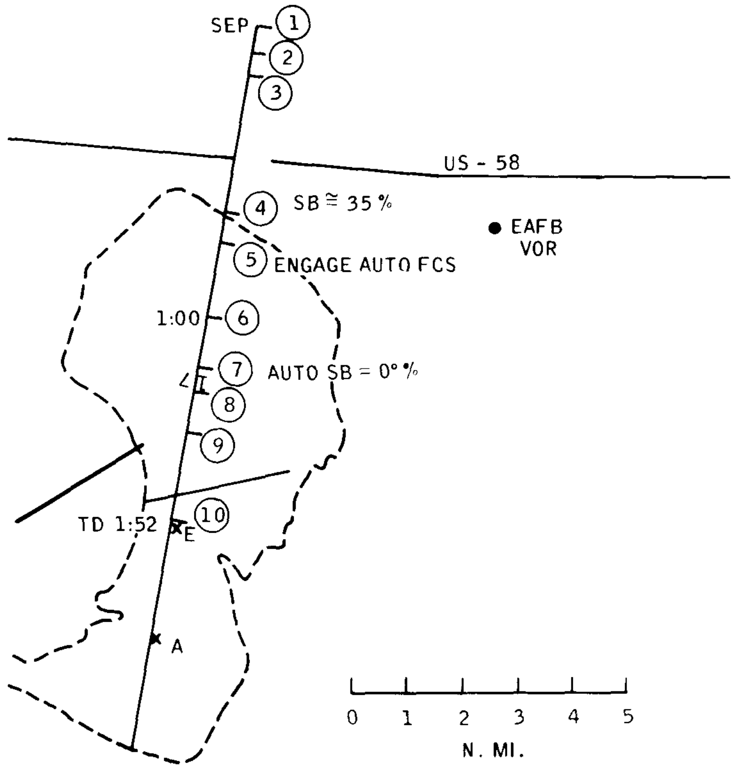


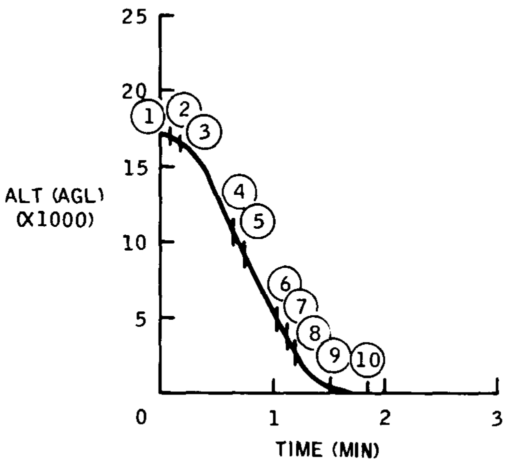
WT = 150,000
CG = 65% (1076.7)

-more-

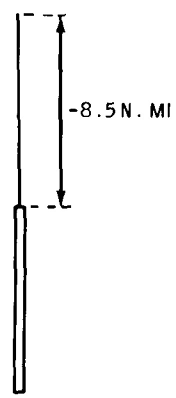
ALT FREE FLIGHT 8

ITEM	TIME	ALT (AGL)	KEAS	α	θ	ACTION
1	0:00	17200	260	10	.5	SEP; $\dot{\theta}$ = 2°/SEC, 3 SEC; $\dot{\theta}$ = 0, 2 SEC
2	0:05	17000	250	7	6.5	ROLL RIGHT ϕ = 20°; $\dot{\theta}$ = -2°/SEC AT θ = -5° ROLL ϕ = 0; CONTINUE $\dot{\theta}$ = -2°/SEC TO θ = -22°
3	0:10	15500	238	5	-22	$\dot{\theta}$ = 0; ACCELERATE TO 290, FLY GUIDANCE ERROR NEEDLES TO LINE UP ON LOCALIZER (ψ = 175) AND GLIDESLOPE (θ = -20.5)
4	0:38	10400	290	4	-20.5	FLY GUIDANCE ERROR NEEDLES AND SB BRAKE COMMANDS ≈ 35%
5	0:44	9000	290	4	-20.4	WHEN THE GUIDANCE NEEDLES ARE CENTERED, ENGAGE AUTO FCS (WHICH INCLUDES AUTO SB)
6	1:00	5300	290	4	-20.4	CHANGE FCS TO CSS AND BACK TO AUTO (SET MAN SB TO CMDED PRIOR TO SWITCHING FCS MODES)
7	1:10	3100	290	4	-20.4	MONITOR AUTO SB RETRACTION
8	1:15	2000	290	4	-20.4	MONITOR PREFLARE
9	1:30	500	250	6	3	DEPLOY GEAR ON GEAR DEPLOY LITE OR 250 KEAS
10	1:52	0	175	11	11	MONITOR TD
11	1:55	0	160	--	--	BRAKE AS REQUIRED





WT = 150,000
CG = 65% (1076.7)



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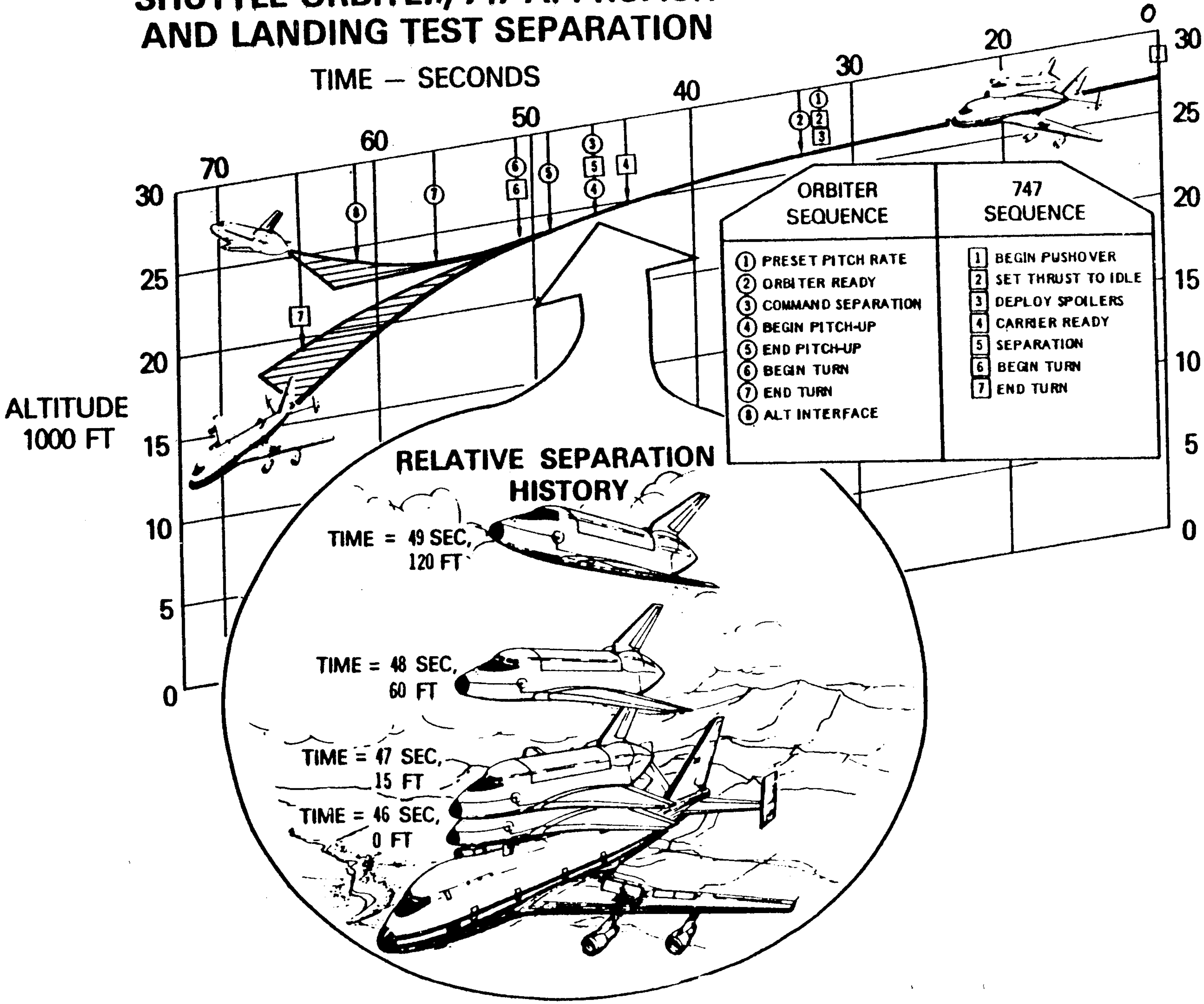
SHUTTLE ORBITER/747 APPROACH AND LANDING TEST SEPARATION



APPROACH AND LANDING TEST TIMELINE

Orbiter Vehicle (OV-101) overland to Dryden Center	January 1977
Taxi runs and begin captive inert flights (6)	February 1977
Begin captive active flights (manned Orbiter) (5)	May 1977
Begin manned free flights (up to 8)	July 1977
Conclude ferry flight phase (3)	March 1978
Ferry flight to Marshall Center, Ala.	March 1978

GROUND VIBRATION TESTS

Orbiter 101 will be ferried from Dryden Flight Research Center, Calif.,to the Marshall Space Flight Center, Huntsville, Ala., for ground vibration tests in March 1978.

It will be mated in the Dynamic Test Facility at Marshall to the 46-m (154-ft.) tall external tank and solid boosters, as it would for actual launch. The tank in flight will carry the 675,000 kg (1.5 million lb.) of liquid hydrogen and liquid oxygen propellants for the Orbiter's three main engines. The two solid boosters will be attached to the external tank. This 56-m (184-ft.)-tall vehicle will undergo low level stress tests during the launch phase, when all the Shuttle engines -- the three main engines of the Orbiter and the two solid boosters -- fire simultaneously furnishing 30 million newtons (6.8 million lb.) of thrust.

The vibration tests are designed to gain information needed for analysis of flight control stability and dynamic loads during the launch and flight phases of the mission. The tests will be conducted in a modified test stand in which the entire 111-m (363-ft.)-tall Apollo Saturn V underwent similar vibration tests in the mid 1960s.

ORBITER AND SYSTEMS OV-101

The Enterprise, Orbiter 101, is comparable in size and weight to a modern transport aircraft. Its length is 37.2 m (122 ft.), wing span 23.8 m (78 ft.), and weighs approximately 68,000 kg (150,000 lb.).

All the Orbiter systems, including avionics, communications, crew equipment environmental control, electrical control and power necessary for the Approach and Landing Test program (ALT), are aboard the vehicle, It lacks the three main engines (three dummy engines are installed), the reaction control system and the orbital maneuvering systems. In addition, simulated tiles are used in place of the thermal protection system which will be used on the orbiters during Earth Orbital flights.

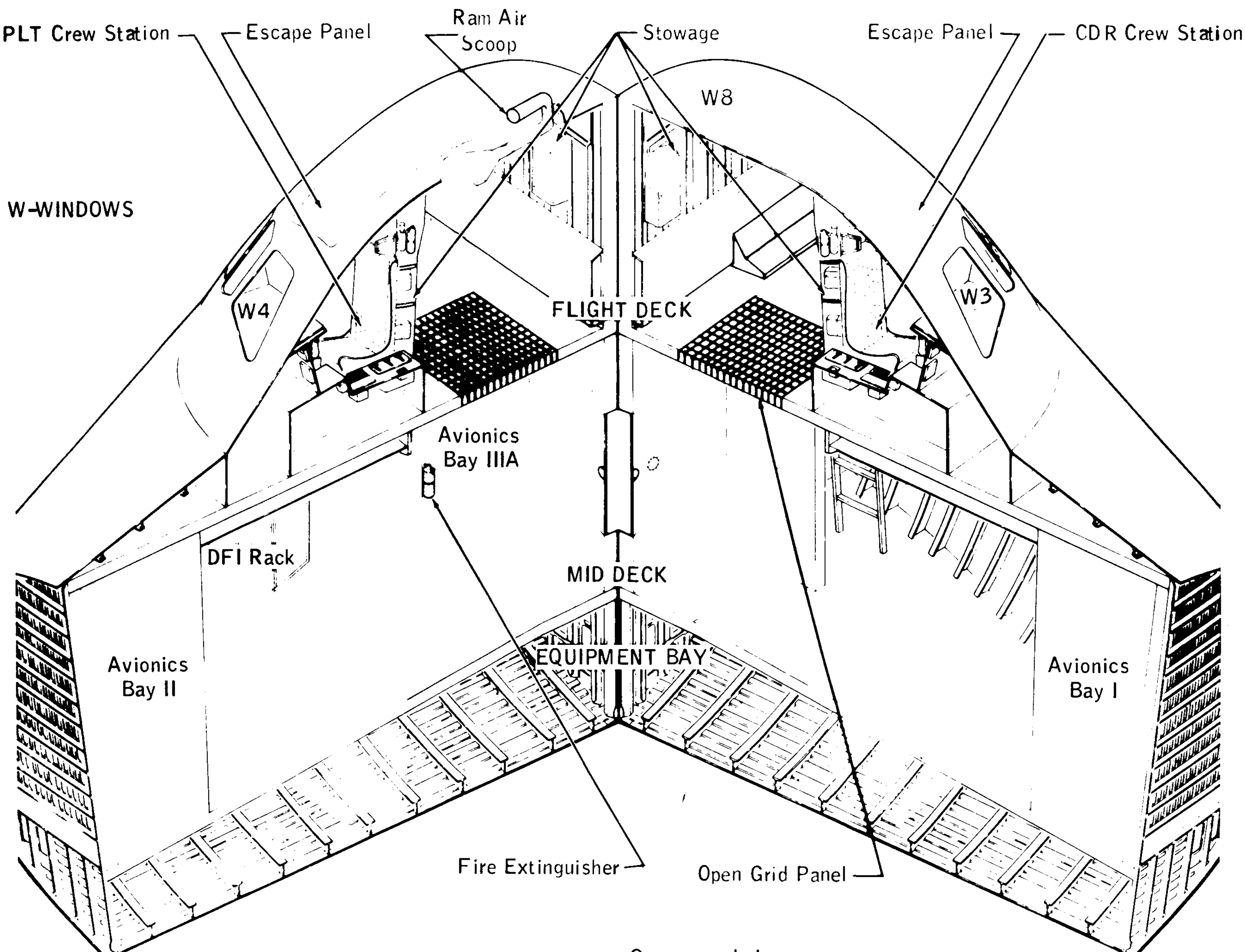
The aerodynamic control surfaces - the body flap at the aft end of the Orbiter, the wing elevons and the rudder/speed brake - provide the control of the Orbiter during the atmospheric portions of the flight. Landing speed of the Orbiter is approximately 185 knots (343 km/hr.),which parallels the performance of current high-performance aircraft.

The majority of the Orbiter structure is of conventional aluminum construction, covered with reusable surface insulation.

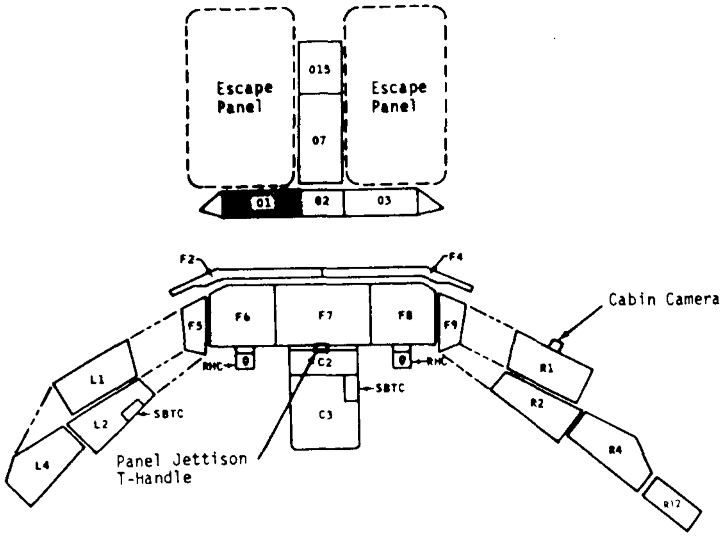
The Orbiter consists of the forward fuselage, the mid fuselage, aft fuselage, wing and vertical tail assembly. These major subassemblies are mated and joined to form the 37.2 m (122 ft.)-long vehicle.

Forward Fuselage and Crew Module - The forward fuselage structure is conventional aircraft construction of 2,024 aluminum alloy skin/stringer panels, frames and bulkheads. The crew module which has a volume of 61 cubic meters (2,150 cubic feet) has three levels or sections - flight deck, the mid-deck and lower section. The crew module is welded construction of aluminum alloy integrally machined panels and floats free within the forward fuselage.

Flight Deck - The flight deck consists of two flight stations; the commander's station which is located on the port side and the pilot's station located on the starboard side of the Orbiter. The displays and controls required for normal and emergency operations for all flights phases are located around the two flight stations. The controls are arranged so that a single crewman operating from either station can land the Orbiter.


PLT Crew Station
Escape Panel
Ram Air Scoop
Stowage
Escape Panel
CDR Crew Station
W8
W-WINDOWS
W4
W3
FLIGHT DECK
Avionics Bay IIIA
DFI Rack
MID DECK
EQUIPMENT BAY
Avionics Bay II
Avionics Bay I
Fire Extinguisher
Open Grid Panel

Crew module.



PANEL NUMBER	DISPLAYS & CONTROLS
O2	• Fuel Cell Meters • Cabin Pressure
O3	• Fuel Cell Purge • Computer Status
O7	• Computers
O15	• Interior Lighting
C2	• CRT Keyboards
C3	• Flight Control System Channel • Air Data Probe • Communications/Navigation • Trim/Body Flap • Inverter/Fuel Cell Circuit Breakers
F2	• Flight Control Modes (Commander's) • Events Sequence (Commander's)
F4	• Flight Control Modes (Pilot's) • Events Sequence (Pilot's)
F5	• 8-Day Clock (Commander's) • Primary Flight Control System Reset
F6	• Commander's Primary Flight Instruments • Landing Gear
F7	• CRT's • Caution & Warning • Surface Position Indicators • Backup Flight Control Displays • Fire Protection
F8	• Pilot's Primary Flight Instruments • Auxiliary Power Unit/Hydraulics Displays • Landing Gear
F9	• 8-Day Clock (Pilot's) • Right Controller Power
L1	• Environmental Control & Life Support System • Operational Instrumentation
L2	• Trim/Body Flap • Audio • Cabin Temperature
L4	• Circuit Breakers
R1	• Power Distribution • Development Flight Instrumentation
R2	• Hydraulics/Auxiliary Power Unit • Fuel Cell • Audio
R4	• Circuit Breakers
R12	• Hydraulics • Auxiliary Power Unit Heaters • Caution & Warning • Utility Power Outlet

-more-

Two ejection seat systems are installed in the flight station and are used for crew seating during normal operations and for emergency escape.

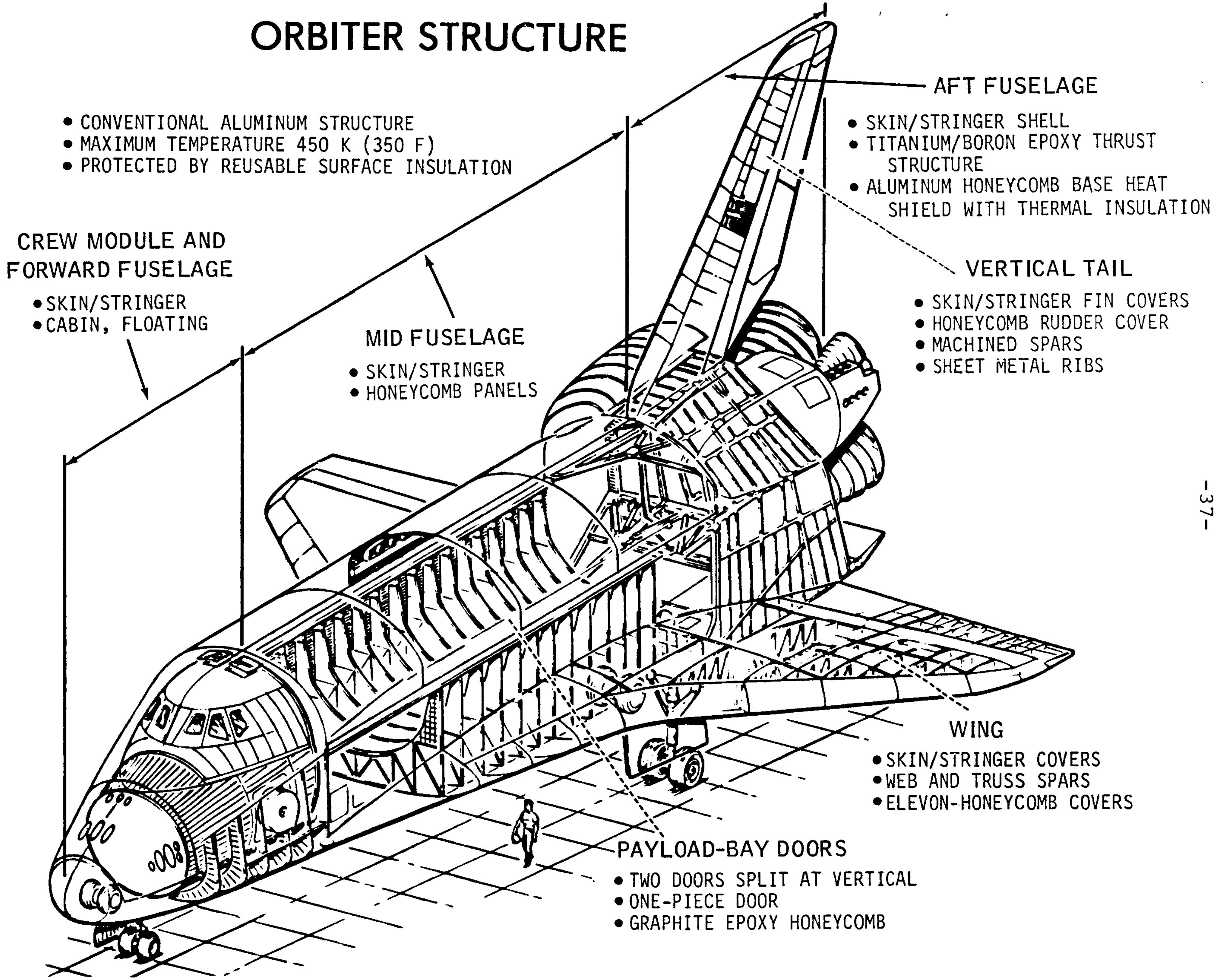
Mid-Deck - The electric and electronic control equipment of the Orbiter are contained in the avionic bays of the mid-deck. Normal crew ingress-egress and emergency egress is provided by a 1.02-m-(40-inch) diameter hatch located on the port side of the mid-deck. In the operational vehicles, the mid-deck constitutes the living quarters of passengers and crew.

Lower Section - The lower section contains the equipment bay which houses the environmental control and life support system (ECLSS) necessary to control cabin and avionics bay temperature, humidity and to distribute conditioned air to the cabin.

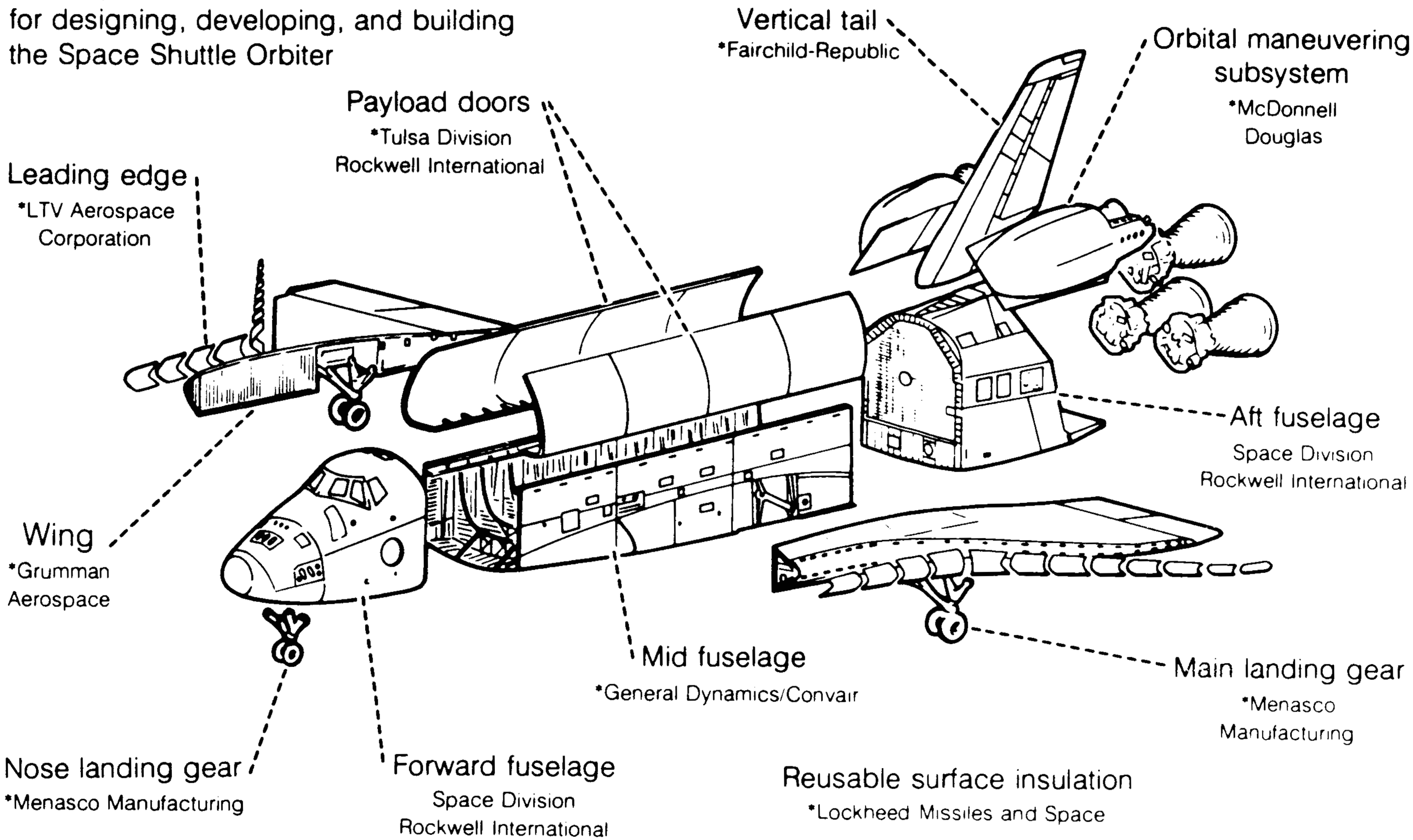
Mid Fuselage - The mid fuselage, similar in construction to the forward fuselage, is a section 18.6 m (61 ft.) which provides the support for the Orbiter payloads. Two payload bay doors of graphite epoxy honeycomb construction fit atop the mid fuselage forming a cargo bay of 18.3 x 4.6 m (60 ft. x 15 ft.).

Aft Fuselage - The aft fuselage is approximately 5.49 m (18 ft.) long, 6.7 m (22 ft.) wide and 6.1 m (20 ft.) high. The aft fuselage supports and interfaces with the removable OMS pods, two wing spars, vertical tail assembly, body flap, two external tank aft attachments the three main engines and three avionics bays.

ORBITER STRUCTURE



The Space Division of Rockwell International
is also prime contractor to NASA
for designing, developing, and building
the Space Shuttle Orbiter



*Orbiter subcontractors (contracts with Space Division)

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ORBITER SYSTEMS

Electrical, Environmental and Mechanical

Three fuel cells will provide electrical power for the Enterprise, as for all subsequent vehicles. For ALT only, gaseous oxygen and hydrogen will replace cryogenics for the fuel supply. Sufficient quantities for oxygen and hydrogen will allow for 208 minutes of electrical power operation.

The atmospheric revitalization system consists basically of the cabin fans and a special ram air vent system (just for ALT) for cabin air purification. The Orbiter's active thermal control system for ALT consists of a series of Freon loops which are cooled by an ammonia boiler supplied by six special add-on tanks located in the cargo bay.

Three auxiliary power units (APU) and hydraulics (HYD) units, essentially the same as those on subsequent vehicles, will provide hydraulic power for operation of the aerodynamic control surfaces (body flap, elevons, rudder/speed brake) and the landing gear. Sufficient fuel (hydrazine) for the power units and hydraulic cooling water will be carried aboard the vehicle to allow 129 minutes of system operation.

Guidance, Navigation and Control (GN&C)

Three inertial measurement units (IMUs) are installed to provide output signals proportional to both vehicle attitude and velocity changes. Analog measurements of the angular rates about the vehicle pitch, roll and yaw axes will be furnished by three rate gyro assemblies (three per axis).

Six body-mounted accelerometers-three for the normal axis and three for the lateral axis-will furnish analog measurements of the acceleration.

Three microwave scanning beam landing systems (MSBLS) are aboard the ALT vehicle to provide elevation, azimuth and range data relative to ground based MSBLS systems for automatic landing.

Other GN&C systems on the first Orbiter are: air data transducer, nose boom, tactical air navigation, radar altimeter, backup flight control system and five general purpose computers.

Communications and Tracking Subsystems

The communications and tracking system for the ALT Orbiter consists of a UHF voice communications subsystem, an Orbiter/Shuttle Carrier Aircraft (SCA) intercom, an S-band Frequency Modulation (FM) transmitter and antenna subsystem for downlinking Orbiter operational instrumentation (OI) and Development Flight Instrumentation (DFI) and a C-band radar beacon and antenna subsystem.

Crew Equipment - Orbiter

The ALT crewmen aboard the Orbiter will wear standard low altitude flight clothing. The flight clothing consists of the basic suit, helmet, boots, and gloves.

The helmet is a customized flying helmet which contains earphones, an earphone jack receptable, an adjustable sunshade-visor and two receivers for oxygen mask attachment. The flight suit is fabricated from Nomex material and contains pockets for pens, pencils, and other ancillary equipment.

Shuttle Carrier Aircraft (SCA)

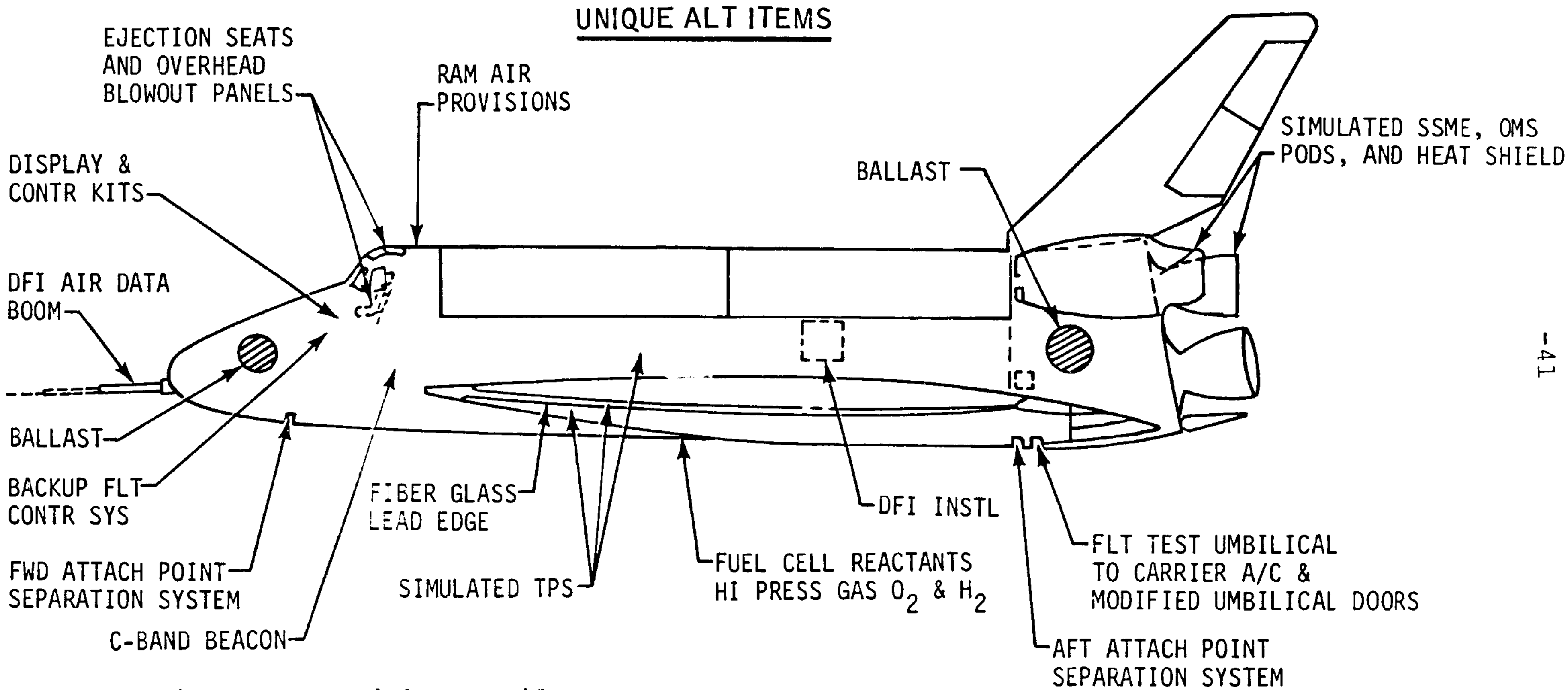
The SCA, a Boeing 747, purchased by NASA in the summer of 1974, has been modified at the manufacturer's facilities in Everett, Wash. The 70.4-m-(231-ft.-) long aircraft has had the majority of its seats and passenger accommodations replaced by equipment and instruments required to support the Orbiter test flights. Structural modifications include addition of reinforcement frames and panels. Panels and stabilizer tip fins have been attached to the horizontal stabilizer.

Support struts (two aft, one forward) have been added to the aircraft to hold the Orbiter. The Orbiter will be affixed to these points and, at the proper moment in flight, explosive bolts will release the Orbiter from the SCA.

In addition to serving as the carrier aircraft for the approach and landing tests, the 747's primary purpose is to ferry the Orbiter from Dryden to the NASA Kennedy Space Center launch facilities in Florida. The SCA will also be used to ferry the Orbiter to launch facilities at Vandenberg Air Force Base, near Lompoc, Calif.

ORBITAL SYSTEMS NOT INSTALLED

- OMS
- RCS
- SSME'S
- EPS CRYO TANKS
- PAYLOAD ACCOM
  - WATER, WASTE, & FOOD MGMT SYSTEM
- RADIATORS
- TPS
- CREW STATION
  - PAYLOAD SPEC
  - ON ORBIT
- STAR TRACKERS
- UNIFIED S-BAND
- RENDEZVOUS RADAR AND KU-BAND



NOTE: Orbiter shown without tailcone

OV 101 configuration for ALT.

In addition to the modifications necessary for the 747 to serve as a carrier and ferry aircraft, an emergency escape system has been added to the former passenger jetliner.

The modifications include a quick exit for flight crews and other personnel through a tunnel which has been installed directly behind and below the flight deck. This exit tunnel extends from the flight deck level to the bottom side of the 747. The 81 centimeter (32-inch)-diameter tunnel has been equipped with an aerodynamic spoiler which will be extended below the aircraft to aid personnel in exiting beneath the airstream of the 747. Individual parachutes will be provided for all those aboard the 747.

Flight Control Operations

Real time flight control functions will be performed by flight controllers located at Dryden Center for the captive inert flights and the Johnson Space Center, MCC-H for those flights in which the Orbiter is manned.

Inert Flights - Dryden

"NASA 1," the call sign of the control room at Dryden Flight Research Center, has been used for the flight control of such experimental aircraft as the X-1E, X-15, XB-70 and other flight research programs. It is the prime control room for the inert phase of ALT.

The room is four separate areas; the dynamic analysis room, the mission analysis room, the telemetry processing room and the flight monitoring room. The first three rooms receive inflight data that is necessary for the safe control of the flight.

Two large radar plot boards are located in the flight monitoring room which trace the track of the SCA/Orbiter to aid the flight controller in guiding the SCA/Orbiter throughout the test maneuvers and to the launch point.

The room is manned by a joint government/industry team of engineers. Communications between the flight crew and the room are restricted to the flight controller.

Active Flights - MCC-H (Mission Control Center - Houston)

All Orbiter and 747 instrumentation data will be recorded onboard the respective vehicles. Other selected Orbiter and 747 data, including selected wideband data, will be transmitted to and recorded on the ground.

Orbiter operational instrumentation and development flight instrumentation and limited 747 data will be sent to the MCC-H as well as realtime ground radar data and voice communication (Orbiter, 747 and chase aircraft) will be transmitted to MCC-H.

The flight control team at JSC is headed by the ALT Flight Director who will direct the test activities to insure that the flight test is providing the best possible returns in relation to test objectives and is being accomplished consistent with flight safety.

The MCC-H ALT flight team consists of the following Flight Test Engineers (FTE):

- EECOM - (Electrical, Environmental and Mechanical) This FTE is responsible for operational knowledge, evaluation and monitoring of hydraulic electrical, environmental and mechanical systems of the Orbiter. He will be assisted by one additional test engineer.

- GNC - (Guidance, Navigation and Control) The GNC FTE is responsible for guidance, navigation and control systems of the Orbiter. The GNC will be supported by three additional test engineers.

- INCO - (Instrumentation and Communication) The INCO test engineer is responsible for the Orbiter instrumentation and communication and in addition he is responsible for handling onboard and ground communication anomalies when they occur. He will be assisted by one test engineer.

- FIDO - The Flight Operations Engineer or FIDO is responsible for monitoring the trajectory and onboard navigation and guidance, including the operation of related software.

- NETWORK - The network controller is responsible for the operational direction and control of the S-band/L-band ground station (Buckhorn) and the MCC-H ground instrumentation systems and personnel.

ORBITER/SCA MATED CONFIGURATION

ENGINES

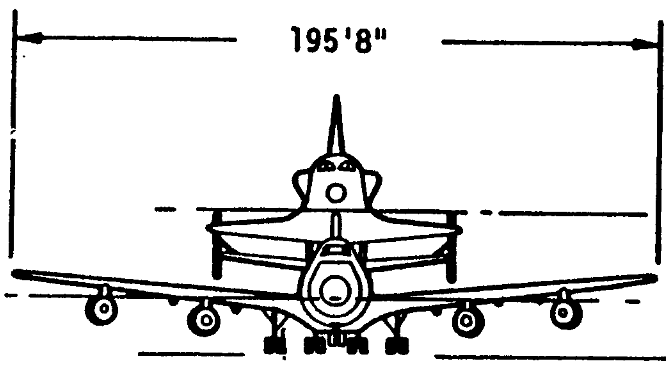
P & W JT9D-7AH

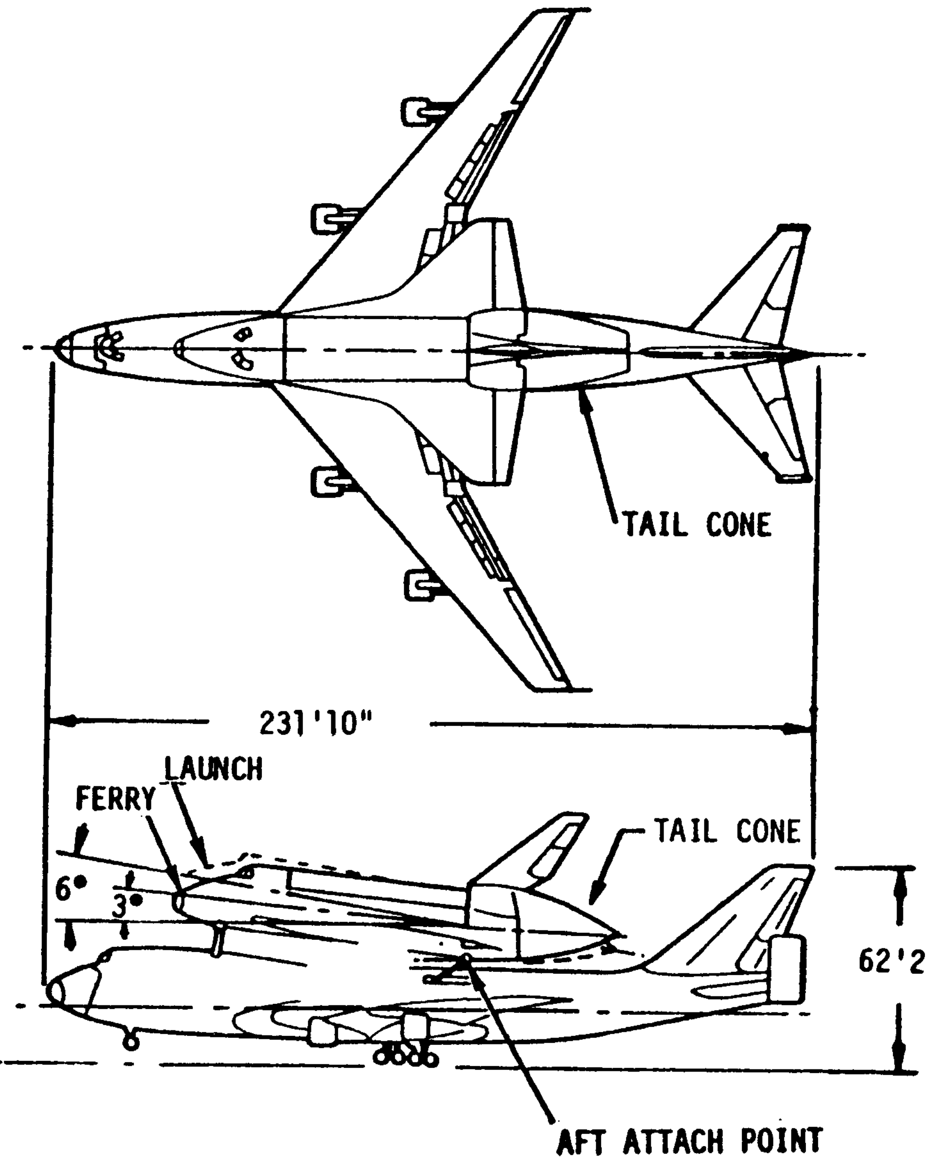
MAX THRUST (TAKEOFF)-46,950 LB PER ENGINE

WEIGHT

SCA

- MAX. TAXI GROSS WT. - 738,000 LB.
- MAX. LANDING WT. - 564,000 LB.





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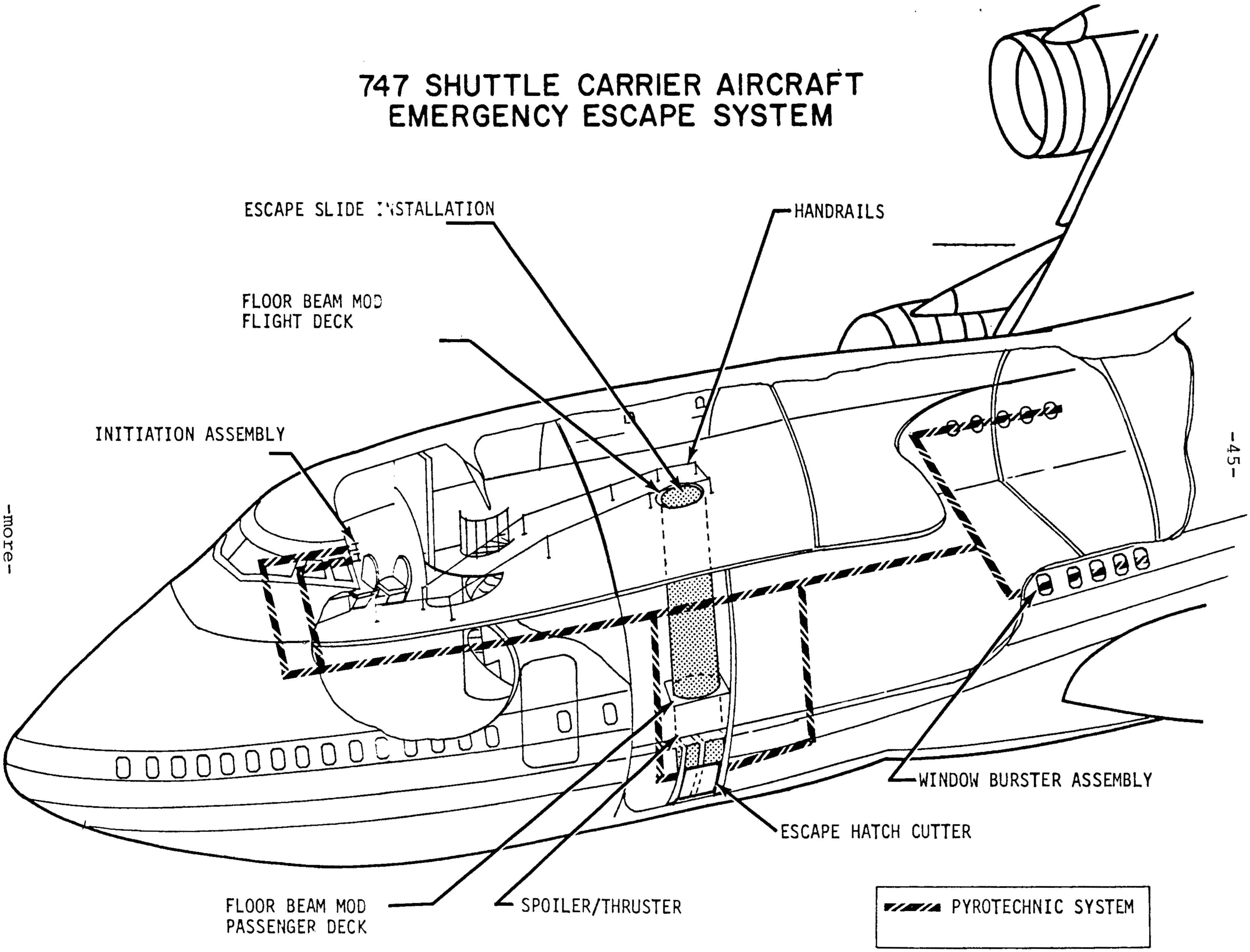
747 SHUTTLE CARRIER AIRCRAFT EMERGENCY ESCAPE SYSTEM



● CAPCOM - (Capsule Communicator) The air-to-ground communicator will perform the traditional role of voice communications with the Orbiter, 747, chase aircraft crews and some ground support equipment during all phases of the flight.

● S&C - (Stability and Control) The stability and control officer is responsible for assuring the vehicle flight characteristics are within planned operational limits.

● L&D - (Loads and Dynamics) The Loads and Dynamics test engineer will monitor the attach point loads between the Orbiter and 747 during mated flight and the Orbiter loads during free flight.

● RANGE - The Range coordinator will interface with both the Network Controller and the Flight Operations Engineer during realtime operations.

Facilities at Dryden and Edwards AFB

Runway Complex

There is a hard-surface runway at Edwards Air Force Base, runway 4-22, which is 4,572 m (15,000 ft.) long and 91 m (300 ft.) wide. When landing to the northeast on runway 4, there is an overrun that extends to the dry lakebed.

Rogers Dry Lake is 168 square km (65 square mi.) (normally) dry lake bed with seven marked runways. The longest runway, 17-35, is 12 km (7.5 mi.) long and has been selected as the prime landing site for the free flights of the Shuttle. Two lakebed runways are 91 m (300 ft.) wide and marked X to aid the pilots.


NASA

Mate/Demate Device

The Mate/Demate Device (MDD) provides the hoisting capability for lifting the Shuttle Orbiter during mating or demating operations on the 747.

The main steel structure consists of two 30-m (100-ft.) tall towers with platforms at 6, 12, 18 and 24 m (20, 40, 60 and 80 ft.) on each tower, and a horizontal structure mounted at 24 m (80 ft.) between the towers. This horizontal structure cantilevers out 21 m (70 ft.).

Three 45,360-kg (100,000-lb.) hoists connected to a lift beam provide hoisting capability. Two hoists are connected aft and one hoist forward. The three hoists operate simultaneously in the lifting operation.

To service the Orbiter during Approach and Landing (ALT) operations, two service access platforms are provided, one on each side of the Orbiter. The platforms are normally stored when not in use at the 18-m (60-ft.) level and are lowered to the Orbiter by two telescoping tubes mounted on the cantilever section.

Two equipment hoists, each capable of carrying 4,360 kg (10,000 lb.) or 25 people, are installed on each tower. These hoists operate to the 18-m (60-ft.) level.

The MDD was designed by Connell Associates, Inc., of Coral Gables, Fla., and constructed by the George A. Fuller Co., Chicago, Ill., for a construction cost of $1,700,000.

The ALT hangar is a single bay hangar with two 22,680-kg (50,000-lb.) bridge cranes. Dimensions of the hangar are 54 x 43 x 24 m (176 x 140 x 80 ft.) high. A shop annex of 622 square m (6,700 square ft.) for tools, supplies and equipment is located on the north side of the hangar.

An 18-m (60-ft.) wide, 38-cm (15-in.) thick paved tow-way connects the hangar, the MDD and the existing airfield pavement at Dryden Center.

The hangar was designed by Voorheis, Trindle and Nelson (VTN) of Irvine, Calif., and constructed by Santa Fe Engineers, Inc., Lancaster, Calif., at a construction cost of $3,700,000.

PHOTOGRAPHY AND TELEVISION

Photographic equipment used during the Shuttle Approach and Landing Tests includes still and television cameras for air-ground coverage and still and motion picture cameras for onboard coverage. The television cameras will have the capability to produce a live picture or a delayed playback with the use of video tape recorders (VTR).

The equipment will record the takeoff, orbiter-carrier separation, crew activities, approach and landing of the orbiter craft.

Television sources consist of one color camera mounted in the T-38 chase plane; one color camera mounted atop the Mobile TV Van; a color Long Range Optics camera (LRO); a camera equipped helicopter (KNBC); and a portable camera to be used as a backup to the T-38 chase plane.

Ten 16 mm cameras using medium speed color film are located in the cabin, landing gear wells and orbiter-carrier attachment points. These cameras will photograph inflight and landing activities. There will be no onboard television cameras during ALT.

Twelve color TV monitors are located in the DFRC News Center and Press working area. The monitors will be fed "best source" video.

SPACE SHUTTLE ALT CREWS

NASA has selected two two-man crews for the Space Shuttle Approach and Landing Test (ALT), the initial flight test of the Shuttle Program. The ALT free flight tests are scheduled to begin in July 1977.

The two crews are: Fred W. Haise, Jr., commander and Charles G. Fullerton, pilot; Joe H. Engle, commander and Richard H. Truly, pilot. Both crews are scheduled to fly ALT missions, with Haise and Fullerton making the first flight.

The crews will participate in the various phases of orbiter test and checkout between now and the first flight. Both crews will train for the flights using the Shuttle Training Aircraft, a modified, twin jet Gulfstream II and the Orbiter Aeroflight Simulator.

Haise, 42 (civilian), commander of the first crew was selected for the astronaut program in April 1966. He was backup lunar module pilot for Apollos 8 and 11, lunar module pilot on Apollo 13 and backup commander on Apollo 16 He is the only crewman named that has flown in space.

Fullerton, 39 (Lieutenant Colonel, USAF), pilot of the first crew, was one of the USAF Manned Orbiting Laboratory Program crewmen selected for the astronaut program in September 1969. He was a member of the support crews for the Apollo 14 and 17 missions.

Engle, 43 (Colonel, USAF), commander of the second crew, was selected for the astronaut program in April 1966. He was a member of the astronaut support crew for Apollo 10 and the backup lunar module pilot for the Apollo 14 mission.

Truly, 38 (Commander, USN), pilot for the second crew, was one of the USAF Manned Orbiting Laboratory Program crewmen selected for the astronaut program in September 1969. He was a member of the support crew for all three Skylab missions.

747 CARRIER AIRCRAFT CREW

Crew members for the 747 carrier aircraft are Fitzhugh L. Fulton, Jr. and Thomas C. McMurty, pilots; Victor W. Horton and Thomas E. Guidry, Jr., flight test engineers.

- more -

Fulton, McMurty and Horton are from the NASA Dryden Flight Research Center and Guidry is a flight engineer from NASA's Johnson Space Center.

Fulton is a veteran multi-engine test pilot with wide experience as a launch pilot. He was launch pilot for the X-15 and for manned lifting bodies, as well as on other experimental aircraft flight test programs. He was an XB-70 project pilot for NASA and the USAF. Currently Fulton is co-project pilot on the triple-sonic YF-12A flight research program.

McMurty has been flying experimental aircraft for NASA since 1967. As project pilot on the Supercritical Wing, he made the first flight with the new airfoil shape. He has flown as co-project pilot on the Digital Fly-by-Wire aircraft and the Supercritical Wing F-111, and as co-project pilot on NASA's 990 and C-141 multi-engine aircraft.

Horton is flight test engineer on the YF-12A at DFRC and has flown as launch panel operator of the B-52A air launch aircraft. Guidry of JSC has flown as test engineer on the C-135 Zero-G studies and the C-130 Earth Resources aircraft.

PROGRAM MANAGEMENT

Overall direction of the Space Shuttle Program is in the Office of Space Flight at NASA Headquarters, Washington, D.C. This office is responsible for the detailed assignment of responsibilities, basic performance requirements, control of major milistones and program funding.

The Lyndon B. Johnson Space Center (JSC), Houston, Tex., is the Space Shuttle lead center and has responsibility for systems engineering and systems integration. JSC is also responsible for development, production, and delivery of the Shuttle Orbiter.

The John F. Kennedy Space Center (KSC), Fla., is responsible for the design of launch and recovery facilities and will serve as the launch site. Edwards AFB, Calif., is the landing site for the first several Shuttle orbiter test flights.

The George C. Marshall Space Flight Center (MSFC), Huntsville, Ala., is responsible for the development, production, and delivery of the Orbiter main engines, the solid rocket boosters and external tank for the hydrogen/oxygen fuel.

Some of the 747 Shuttle Carrier Aircraft Tests and all of the Orbiter Approach and Landing Tests will be conducted at the Dryden Flight Research Center, Edwards, Calif.

SPACE SHUTTLE PROGRAM OFFICIALS

JOHN F. YARDLEY, Associate Administrator for Space Flight, NASA Headquarters, directs NASA's space flight programs, including the Space Shuttle, the United States' efforts in Spacelab, expendable launch vehicles and the engineering studies related to possible future space flight projects. Born in St. Louis, Mo., in 1925, he received a B.S. degree in aeronautical engineering from Iowa State College and an M.S. degree from Washington University. After three years in the Navy during World War II, Yardley joined McDonnell Douglas in 1946 as a structural engineer. From 1958 to 1960, he served as Project Engineer for Mercury spacecraft design; and from 1960 to 1964, he was Launch Operations Manager for the Mercury and Gemini spacecrafts. He was Gemini Technical Director from 1964 to 1967 and Vice President and corporate-wide General Manager for the Skylab project prior to being Vice President and Deputy General Manager, Eastern Division, Astronautics, in 1968. Yardley then became Vice President and General Manager of the Division in 1973 at which position he remained until his appointment to NASA in 1974.

Dr. MYRON S. MALKIN is the Space Shuttle Program Director located at NASA Headquarters. Named to this post in April 1973, he heads overall design, management, integration, development and testing of the Space Shuttle. Dr. Malkin joined NASA after serving as Deputy Assistant Secretary of Defense for Technical Intelligence Evaluation for almost one year. He was president of NUS Corp., an engineering consultime firm, from 1969-71 and earlier held positions as program manager for Titan II and Minuteman III. He was general manager of the Manned Orbiting Laboratory (MOL) program at General Electric from 1961-69. Dr. Malkin was born in Youngstown, Ohio and received B.S., M.S. and Ph. D. degrees from Yale University.

ROBERT F. THOMPSON, the Space Shuttle Program Manager, is located at the NASA Johnson Space Center (JSC). He is responsible for management and integration of major elements of the program. Thompson was appointed to this position in 1970, after serving as manager of the Skylab program through the conceptual design and development phases. He joined NASA's predecessor organization, NACA, in 1947, and was selected as one of the early members of the Space Task Group, the nucleus of JSC. He was chief of the Landing and Recovery Division for Mercury, Gemini, and early phases of the Apollo program, prior to managing the early Skylab effort. He is a recipient of NASA's Outstanding Leadership, Exceptional Service and Distinguished Service medals. Born in Bluefield, Va., Thompson graduated from Virginia Polytechnic Institute with a B.S. in aeronautical engineering.

AARON COHEN is manager of the Space Shuttle Orbiter Project located at NASA's JSC. He is responsible for design, development, production and testing of the Orbiter. He joined NASA at JSC in 1962 as a member of the Apollo Program Office and subsequently held varied executive posts in the program. He was appointed Command and Service Module (CSM) manager in 1970, directing CSM efforts on both Apollo and Skylab programs until his appointment to the Space Shuttle post in 1972. Cohen has earned two NASA Exceptional Service Awards, the NASA Certificate of Commendation and the NASA Distinguished Service Medal. Born in Corsicana, Tex., he has a B.S. in mechanical engineering from Texas A&M and an M.S. in applied mathematics from Stevens Institute of Technology.

DONALD K. SLAYTON is Manager for the Approach and Landing Tests Space Shuttle Program Office at JSC. He has overall program responsibility for managing the approach and landing test efforts and is responsible for integration of these activities at JSC, KSC and DFRC and other NASA Centers as required. Slayton was docking module pilot during the Apollo Soyuz Test Project in July 1975. He joined NASA as one of the original seven astronauts in 1959 and until his assignment to the ASTP crew, served as Director of Flight Crew Operations at JSC. He is the recipient of two NASA Distinguished Service Medals, the NASA Exceptional Service Medal, the Collier Trophy and numerous other honors from universities and organizations. A native of Sparta, Wis., Slayton is a graduate of the University of Minnesota where he received a Bachelor of Science degree in aeronautical engineering.

DR. ROBERT H. GRAY was named Space Shuttle Projects Office manager for NASA's Kennedy Space Center (KSC) in July 1973. He manages Space Shuttle operations planning, facilities preparations leading to launch, landing activities and refurbishment of the craft. Earlier, Dr. Gray was KSC deputy director of Launch Operations and director of Unmanned Launch Operations, directing more flights (178) than any engineer in the free world. He joined NASA in 1958 after three years as the Vanguard Launch Director and Deputy Manager of the Vanguard Group at Cape Canaveral for the Naval Research Laboratory. Gray was named chief of Goddard Space Flight Center Field Projects Branch in 1959, a post he held until going to KSC in 1965. Honors accorded Gray include the Navy's Outstanding Performance Award for the Vanguard program and from NASA the Distinguished Service Award and the Exceptional Service Medal. Gray graduated from Allegheny College, Pa., with a B.S. in physics and recieved an honorary Doctorate of Science from Allegheny in 1968. Dr. Gray was born in Cambridge Springs, Pa.

ROBERT E. LINDSTROM has been manager of the Shuttle Projects Office at NASA's Marshall Space Flight Center (MSFC) Huntsville, Ala., since March 1974, after serving as deputy manager for the preceding two years. From 1970-72, he was deputy director of MSFC's Process Engineering Laboratory. Prior to 1960, he was with the Army Ballistic Missile Agency as a Saturn project engineer and as project engineer for the Jupiter C vehicle which launched Explorer I. He joined MSFC in 1960 as manager of the Saturn I/IB program. Lindstrom left government employment in 1963, to serve in top posts in industry but rejoined Marshall in 1970. He holds numerous awards, including NASA's Exceptional Service Medal and the Director's Commendation Certificate. He was born in Sycamore, Ill., and received a B.S. degree in ceramic engineering from the University of Illinois.

GEORGE B. HARDY is manager of the Solid Rocket Booster project, Space Shuttle program, for MSFC. Earlier he served as manager of the Program Engineering and Integration project, Skylab program; assistant manager of the S-1B Launch Vehicle project; and deputy project manager for S-1/1B Stage Project in the Saturn program. Hardy began his professional career in 1952 with E. I. Dupont in Georgia; he moved to the Redstone Arsenal in 1958 and transferred to MSFC in 1962 as a project engineer. He is a native of Russellville, Ky., and graduated from Georgia Institute of Technology in 1952 with a B.C.E. in civil engineering.

JAMES B. ODOM is manager of the External Tank project, Space Shuttle program, at NASA's MSFC. Odom began his professional career in 1955, with Chemstrand Corporation, Decatur, Ala. He moved in 1956, to the Army Ballistic Missile Agency and in 1959, joined the organization that became MSFC in 1960. He has been associated with Earth satellite programs, lunar unmanned probes and the Apollo program. A native of Georgiana, Ala., Odom was graduated from Auburn University with a B.S. in mechanical engineering in 1955.

JAMES R. (BOB) THOMPSON, JR. is manager of the Space Shuttle Main Engine Project at NASA's MSFC. He served earlier as chief of MSFC's Man/Systems Integration Branch, Astronautics Laboratory. Thompson joined the propulsion research development team at MSFC in 1963, where he was responsible for component design and performance analysis of the engine system on Saturn launch vehicles. He is from Greenville, S.C.; and is a graduate of the Georgia Institute of Technology (1958) and the University of Florida (1963), with a B.S. in aeronautical engineering and an M.S. in mechanical engineering He is seeking a Ph.D. in fluid mechanics at the Univers of Alabama.

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ISAAC THOMAS GILLAM IV is Director of Shuttle Operations at Dryden Flight Research Center and is responsible for the Dryden activities in support of the ALT of the Orbiter. Prior to this, he was Delta Program Manager and Program Manager of Small Launch Vehicles in NASA Headquarters. Before his NASA assignment, Gillam served in the U.S. Air Force from 1953 to 1963 as a pilot, missile launch crew commander and ROTC instructor. After graduating from Howard University, Washington, D.C., Gillam attended Tennessee State University while working on graduate studies and serving as Assistant Professor of Air Science. Among other awards, Gillam has received the NASA Distinguished Service Medal for the Launch Vehicle Program. Gillam is a native of Little Rock, Ark.

DONALD R. PUDDY is flight director of Approach and Landing Test, Flight Control Division for the Space Shuttle Program at the Johnson Space Center. Past experience includes flight director for the Apollo Soyuz Test Project, and all the Skylab missions.

In Apollo he was Lunar Module environmental and electrical engineer (EECOM) for Apollos 5, 9 and 10, and during the powered descent and ascent of the LM on Apollo 11. He served as LM spacecraft analysis flight controller during Apollos 12, 13, 14 and 15. He was flight director on Apollo 16 and served as command and service module (CSM) spacecraft analysis flight controller for Apollo 17. Before assuming his present position he was chief of the Mission Operations Branch.

Puddy joined NASA in 1964 after four years in the U.S. Air Force working in high altitude research. He was born in Ponca City, Okla. He has a B.S. degree in mechanical engineering from the University of Oklahoma (1960), and is working toward a Master of Business Administration degree at the University of Houston, Clear Lake, Tex.

JOHN A. MANKE is the Chief of Flight Operations at the Dryden Flight Research Center. Prior to becoming Chief of Flight Operations, Manke was a civilian research pilot and assigned to the wingless lifting body flight research program that was demonstrating man's ability to maneuver and safely land a vehicle with a shape that was designed for space flight. As such, he flew the M-2, HL-10 and X-24 lifting bodies and made the first supersonic flight in a lifting body. Born in Selby, S.D., on Nov. 13, 1931, Manke attended the University of South Dakota before joining the U.S. Navy in 1951. He was selected for the NROTC program and graduated from Marquette University, Wisc., in 1956 with a bachelor's degree in electrical engineering. Following graduation, Manke entered flight training and served as a fighter pilot with the U.S. Marine Corps. Leaving the service in 1960, and prior to joining NASA, he worked for Honeywell Corp. as a test engineer.

SPACE SHUTTLE ORBITER - OV 101

CHRONOLOGICAL EVENTS

Aug. 9, 1972	NASA gives authority to proceed on Space Shuttle Orbiter contract. (Selection of Rockwell International's Space Division announced July 16, 1972.)
June 4, 1974	Orbiter Vehicle (OV 101) - Start structural assembly of crew module (Downey)
Aug. 26, 1974	OV-101-Start structural assembly of aft fuselage (Downey)
Mar. 27, 1975	OV-101-Mid fuselage (General Dynamics, San Diego) delivered to Palmdale facility
May 23, 1975	OV-101-Wings (Grumman, N.Y.) delivered to Palmdale facility
May 25, 1975	OV-101-Vertical stabilizer (Fairchild, N.Y.) delivered to Palmdale facility.
Aug. 25, 1975	OV-101-Start final assembly and mating (Palmdale)
Sept. 9, 1975	OV-101-Aft fuselage (Space Division) delivered to Palmdale
Oct. 31, 1975	OV-101-Lower forward fuselage (Space Division) delivered to Palmdale
Nov. 17, 1975	OV-102-Start fabrication of crew module (First orbital flight vehicle)
Dec. 1, 1975	OV-101-Upper forward fuselage (Space Division) delivered to Palmdale
Jan. 16, 1976	OV-101-Crew module (Space Division) delivered to Palmdale
Mar. 3, 1976	OV-101-Cargo bay doors (Tulsa Division) delivered to Palmdale
Mar. 12, 1976	OV-101-Complete final assembly and close-out systems installation (Palmdale)

- more -

Mar. 15, 1976	OV-101-Start functional checkout (Palmdale)
April 19, 1976	OV-102-Start assembly of forward fuselage (Downey)
June 1976	OV-102-Start assembly of crew module (Downey) OV-101-Complete functional checkout (Palmdale) OV-101-Start ground vibration and proof load tests (Palmdale)
Aug.-Sept. 1976	OV-102-Start assembly of forward fuselage (Downey) NASA 747 (Boeing ferry aircraft) - Structural modification (Seattle)
Sept. 17, 1976	Rollout first Space Shuttle Orbiter (Enterprise) OV-101 (Palmdale) OV-102-Start assembly of aft fuselage (Downey)
Oct.-Nov. 1976	OV-101-Start retest (Palmdale) NASA 747 - Complete modification OV-101-Complete integrated systems check-out (Palmdale)
Jan.-Feb. 1977	OV-101- Configuration inspection (Palmdale) Enterprise (101) - Delivered to DFRC OV-102-Deliver mid fuselage to Palmdale 747 Carrier Aircraft delivered to DFRC OV-101-First captive flight with NASA 747 (DFRC)
July-Aug. 1977	OV-101-First free-flight approach and landing test (ALT) (DFRC) OV-102-Start final assembly and closeout systems installation and aft fuselage to Palmdale OV-102-Deliver wings to Palmdale
Sept.-Oct. 1977	OV-102 Deliver crew module, vertical stabilizer, and body flaps to Palmdale
Nov. 1977	OV-102- Complete final assembly and close-out systems installation (Palmdale) OV-102-Start functional checkout (Palmdale)
Jan. 1978	OV-101-Complete free-flight tests

Mar. 1978	OV-101-Deliver Orbiter to Marshall Space Flight Center, Ala. (MSFC) (ferried by NASA 747) for vertical ground vibration test
Apr. 1978	OV-101-Start vertical ground vibration (MSFC)
May 1978	OV-101-Deliver external tank for vertical ground vibration test to MSFC Ala.
July 1978	OV-102-Complete configuration inspection (Palmdale) OV-102-Final acceptance rollout (Palmdale)
Aug. 1978	OV-102-Deliver first orbital flight vehicle to Kennedy Space Center (KSC), Fla.
Dec. 1978	OV-101-Complete vertical ground vibration test (MSFC) OV-102-Ready for transfer to Pad 39A (KSC)
Feb. 1979	OV-101-Deliver to Rockwell, Palmdale, and start modification.
Mar. 1979	OV-102-First manned orbital flight, Space Transportation System (KSC)

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ADA-3

NASA News

National Aeronautics and
Space Administration

Washington, D.C. 20546
AC 202 755-8370

For Release:

IMMEDIATE

Bill O'Donnell
Headquarters, Washington, D.C.
(Phone: 202/755-0816)

RELEASE NO: 77-18

SPACE SHUTTLE ASTRONAUT APPLICATIONS PASS THE 1100 MARK

NASA has received 1,147 applications for the Space Shuttle astronaut candidate program. Deadline for applying is June 30, 1977.

NASA announced last July that it was seeking at least 15 pilot and 15 mission specialist astronaut candidates. Successful candidates will report to NASA's Johnson Space Center, Houston, Tex., July 1, 1978, for two years of training and evaluation. Final selection into the astronaut program will depend on satisfactory completion of the evaluation period.

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Mailed:
February 1, 1977

Since the space agency is committed to an affirmative action program with a goal of having qualified minorities and women among the astronaut candidates, NASA will make additional efforts to reach these groups.

To date 11,822 applications, forms and announcements have been mailed to requestors outside NASA. Another 350 applications have been sent to employees at the various NASA centers.

All received so far are from civilians. Applications from members of the military services will be provided to the NASA astronaut selection board just prior to the application deadline.

The majority of the requests for application forms and announcements have been for the mission specialist category. Of the 1,147 applications received, 922 are for mission specialist, 225 for pilot and 118 for both categories.

Pilot applicants must have a bachelor's degree from an accredited institution in engineering, physical science or mathematics or have completed all requirements for a degree by Dec. 31, 1977. An advanced degree or equivalent experience is desired.

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They must have at least 1,000 hours first pilot time, with 2,000 or more desirable. High performance jet aircraft and flight test experience is highly desirable. They must pass a NASA Class 1 space flight physical and be between 64 and 76 inches in height.

Applicants for mission specialist candidate positions are not required to be pilots. Educational qualifications are the same as for pilot applicants except that biological science degrees are included. Mission specialist applicants must be able to pass a NASA Class 2 space flight physical and be between 60 and 76 inches in height.

Civilian applicants may obtain a packet of application material from JSC. Requests should be mailed to either Astronaut (Mission Specialist) Candidate Program or Astronaut (Pilot) Candidate Program, Code AHX, NASA Johnson Space Center, Houston, Tex. 77058.

Military personnel should apply through their respective services using procedures announced by the Department of Defense. Military candidates will be assigned to JSC but will remain in active military status for pay, benefits, leave and other military matters.

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The Space Shuttle will be launched like a rocket, perform Earth orbital missions of up to 30 days, then land like an airplane and be refurbished for another mission. Pilot astronauts will control the Shuttle during launch, orbital maneuvers and landings and be responsible for maintaining vehicle systems. Mission specialist astronauts will have overall responsibility for the coordination, with the commander and pilot, of Shuttle operations in the areas of crew activity planning, consumables usage and other Shuttle activities affecting experiment operations.

Crews could consist of as many as seven people -- commander, pilot, mission specialist and up to four payload specialists, who need not be NASA employees and who will be nominated by the sponsors of the payload being flown. Payload specialists will operate specific payload equipment where their special skills are needed.

Potential users of the Space Shuttle include government agencies and private industries from the United States and abroad.

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ADA-3

NASA News

National Aeronautics and
Space Administration

Washington, D.C. 20546
AC 202 755-8370

For Release:

Bill O'Donnell
Headquarters, Washington, D.C.
(Phone: 202/755-0816)

IMMEDIATE

RELEASE NO: 77-19

SPACE TELESCOPE PROPOSALS SOUGHT FROM INDUSTRY

NASA has invited industry to prepare bids for the procurement of major elements of the Space Telescope which is included in NASA's Fiscal Year 1978 budget, recently submitted to Congress for approval.

Requests for Proposals (RFPs), released to industry on Jan. 28 by NASA's Marshall Space Flight Center, Huntsville, Ala., call for design, development and manufacture of the Space Telescope's Support Systems Module (SSM) and Optical Telescope Assembly (OTA). Contracts are expected to be awarded in October or November, 1977, if Congress authorizes the Space Telescope and appropriates the required funding.

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Mailed:
February 1, 1977

The planned Space Telescope would weigh about 10 tons and would orbit the Earth at an altitude of approximately 500 kilometers (310 miles) at an inclination of 28.8 degrees to the equator. The 2.4-meter (8-foot) diameter telescope, capable of accommodating up to five different instruments at its focal plane, would be placed in orbit in 1983 by the Space Shuttle. Once placed in orbit, it would be operated remotely from the ground but would be designed to permit maintenance and the change of instruments by a space-suited astronaut. Also it would be retrievable by the Space Shuttle for return to Earth for overhaul and subsequent relaunch. These features should allow the Space Telescope to serve as an in-space astronomical observatory for more than a decade.

The Space Telescope should permit scientists to study mysteries relating to the structure, the origin, the evolution and the little-understood energy processes of the universe which could never be approached using observatories below the obscuring veil of the Earth's atmosphere. With it, astronomers should be able to observe some 350 times the volume of space that can be studied using the largest ground-based telescopes.

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NASA expects to issue an Announcement of Opportunity to the science community in February to solicit proposals for scientific instruments to be carried on the initial launch of the Space Telescope.

-end-

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For Release:

IMMEDIATE

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RELEASE NO: 77-20

NASA PLANS VARIETY OF EXHIBITS AT PARIS AIR SHOW

Economical space transportation and aircraft energy efficiency highlight NASA's space and aeronautics exhibit planned for the United States Pavilion at the 32nd Paris Air Show.

Following the 1977 U.S. Pavilion theme "The Continuous Challenge -- 50 Years Since Lindbergh," NASA provides a glimpse into its ongoing research and technology efforts to develop safer, more efficient and environmentally acceptable civil transport aircraft.

Models and presentations demonstrate the breadth of NASA's aeronautical programs, including the NASA/U.S. industry effort to reduce fuel consumption in future civil transports by a hefty 50 per cent.

-more-

Mailed:
February 7, 1977

An extension of airborne flight into space, NASA's revolutionary new space transportation system -- Space Shuttle -- will increase man's capabilities and flexibility in Earth orbital space operations.

When payload flights begin in the 1980s, costs will be reduced by more than 50 per cent. The 2.4-meter (8-foot) Shuttle model includes the European Space Agency (ESA) Spacelab in its cargo bay, an early payload in a major cooperative, international space program.

NASA's "Galileo II" flying laboratory will be on display with its interior configured to simulate the Spacelab under development by ESA. The reusable Spacelab will provide facilities for conducting space experiments in medicine, manufacturing, astronomy and production of pharmaceuticals.

A life-size panorama of the Mars landscape as seen through the lens of the U.S. Viking Lander spacecraft camera dramatically demonstrates not only space exploration, but the progress of flight since Lindbergh.

Practical applications of space flight are brought into focus by Landsat stereo photographs of Earth taken from space, representing man's growing ability to use space routinely for surveying crops and natural resources, monitoring pollution and weather and collecting meteorological data on a global basis.

The U.S. Pavilion's "Continuous Challenge" theme is emphasized by showing NASA concepts of space communities and their construction; living, farming and manufacturing in space; and solar power stations in space.

A three-screen presentation provides a historical journey through 50 years of flight since Lindbergh.

-end-

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For Release:
IMMEDIATE

RELEASE NO: 77-21

SHUTTLE TESTS BEGIN 15 YEARS AFTER GLENN'S FIRST ORBIT

Fifteen years ago, the United States placed its first man in Earth orbit.

In the decade and a half since Marine Lt. Col. John H. Glenn made his historic three-orbit space flight in Friendship 7 Feb. 20, 1962, U.S. space program has progressed to the point where it is beginning flight tests of the first of a planned fleet of five reusable space vehicles.

Almost to the anniversary day of the Glenn flight, the first Space Shuttle Orbiter, named Enterprise, is scheduled to leave the ground Feb. 17 on the back of a jet airplane for its first trip through Earth's atmosphere.

- more -

Mailed:
February 9, 1977

Where Glenn's trip into space was in a one-man capsule in a mission designed to find out if man could travel successfully through space and survive the Space Shuttle is designed to give people routine access to space and to use and exploit space for the benefit of mankind.

Glenn's trip into space lasted less than five hours. Two earlier sub-orbital space missions by Astronauts Alan Shepard and Virgil I. "Gus" Grissom accumulated a half hour of space flight experience.

Now as the Space Shuttle Orbiter is prepared for its first captive flight aboard a Boeing 747 aircraft, the United States has a background of 22,504 man-hours in space flight, accumulated by 43 astronauts on 31 separate manned missions, including nine trips around the Moon, six landings on the Moon and earth-orbital missions of three months.

This experience has demonstrated that people can survive space journeys and weightlessness for long periods and they can work effectively in space. NASA space exploration also has shown that the space environment offers advantages to be used for the benefit of people on Earth.

Glenn's Mercury spacecraft weighed 1,315 kilograms (2,900 pounds), barely had enough room inside for Glenn and a few instruments, and was designed for one-time use. It landed in the Atlantic Ocean by parachute.

The Space Shuttle Orbiter, by contrast, weighs 67,500 kg (150,000 lbs) empty, has room for up to seven crewmen and a cargo bay capable of handling payloads of up to 29,480 kg (65,000 lbs) and as large as 4.5 meters by 18 meters (15 feet by 60 feet). It will glide to a landing on a runway and be prepared for use again in a few weeks.

While the Space Shuttle Orbiter will be manned in the sense that it will have a crew, many of its missions will be flown to place in orbit automated satellites that today are launched by expendable vehicles. Many of its missions will carry Spacelab into orbit. Spacelab is a large laboratory manned by up to four scientists and technicians to carry out experiments in Earth orbit. Spacelab missions will last seven to 30 days with Spacelab being returned to Earth after completion of a mission.

- more -

Fifteen years ago John Glenn made an exploratory three-orbit flight to probe the mysteries of space. Today the NASA Space Shuttle Orbiter is ready to take its first short flights in a program to exploit the no-longer mysterious resources of near-Earth space.

The first of six Earth-orbital flight tests of the Space Shuttle is scheduled for 1979 and the first of hundreds of operational flights is scheduled for 1980.

- end -

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For Release
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RELEASE NO: 77-22

NASA CERTIFIES GENERAL AVIATION DESIGN AND ANALYSIS CENTER

NASA has certified the General Aviation Design and Analysis Center (GA/ADAC) at Ohio State University Airport in Columbus, Ohio to perform analysis studies for single element airfoils. This is the first step toward providing a complete service to the general aviation community.

This certification will be followed by a certification for limited single element design. Scheduled to follow soon thereafter will be certification for aerodynamic analysis with flaps and simple aerodynamic controls.

The ADAC was developed under a contract between the NASA Langley Research Center, Hampton, Va., and Ohio State University's Aeronautical and Astronautical Research Laboratory. This contract includes a three year effort to provide services directly to aircraft designers and manufacturers.

- more -

Mailed:
February 9, 1977

Services include analysis and design of two-diminsional airfoil shapes, analytical investigation of high-lift devices and aerodynamic controls, compilation of airfoil aerodynamic characteristics, and technical assistance, consultation and data interpretation for airfoil wind tunnel and flight testing.

Personnel at ADAC, under the directorship of Dr. G. M. Gregorek, will be working closely with NASA to refine existing computational codes for analytic treatment of two-dimensional airfoils. As new techniques and radically improved computation codes are developed by NASA, they will be refined by ADAC to be employed in more difficult and complex airfoil analysis and design problems such as tailoring and optimizing of airfoils and their aerodynamic controls of high lift components.

Services will be provided to industry on a fee charge basis and include computational analysis and technical assistance and consultation for airfoil wind tunnel and flight test.

- end -

ADA-3

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For Release IMMEDIATE

Press Kit

Project Palapa-B

March

RELEASE NO: 77-23

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RELEASE NO: 77-23

NASA TO LAUNCH SECOND SATELLITE FOR INDONESIA

Indonesia's second satellite in a two-spacecraft network for domestic communications is scheduled for launch by NASA aboard a Delta rocket from Cape Canaveral, Fla., no earlier than March 10. The Delta is managed for NASA's Office of Space Flight by the Goddard Space Flight Center, Greenbelt, Md.

Called Palapa-B (Palapa-2 in orbit), the satellite will be placed in synchronous orbit 35,800 kilometers (22,300 miles) above the equator and will be allowed to drift to its on-station position at 77 degrees E. longitude at the rate of two or three degrees a day.

-more-

Initially, it is expected to be placed just south of India. Palapa-1, launched by NASA in July 1976 and operating successfully since then, is located at 83 degrees E. longitude.

With both satellites in operation, radio, telephone and television communications through some 3,000 inhabited islands of Indonesia's 13,000 are expected to almost triple by 1978.

Indonesian officials selected satellite communications because of the tremendous problems and expense in establishing conventional land and underwater communications links. It was not economically or physically possible to install wires and microwave towers cver thousands of miles of ocean, islands, hills and forests.

Forty Earth stations located in the major cities of the nation form the initial ground network for the two satellites with a total of 50 stations planned.

The Jakarta station will monitor and control the other ground stations in the system as well as transmit the signal that fires the spacecraft's on-board apogee kick motor which takes it out of its elliptical 11-hour transfer orbit to place it in synchronous orbit.

Initial monitoring and control functions will be handled from the Western Union control station in Glenwood, N.J.

The two spacecraft are identical to the Canadian Anik and Western Union's WESTAR satellites with the exception of the antenna which has been modified to provide optimum illumination of the Indonesian land mass.

The 12-transponder satellite has an average capacity of 4,000 voice circuits or 12 simultaneous color television channels. It measures 3.7 meters (11 feet) in height (including the antenna) and 1.9 m (6.2 ft.) in diameter. The antenna is a shaped-beam solar transparent 1.5-m (4.8-ft.) diameter parabolic dish.

Launch weight of the spacecraft is 575 kilograms (1,267 pounds) including the apogee kick motor which weighs 293 kg (645 lb.). Design lifetime is seven years.

The Indonesian government will reimburse NASA for the cost of the launch vehicle, launch services and other administrative costs and has arranged for all ground station support required for the launch and control of the satellite.

-more-

There are no requirements for NASA ground station tracking or command support beyond the launch phase.

NASA's Kennedy Space Center, Fla., is responsible for launch operations. Prime contractor for the Delta rocket is McDonnell Douglas Astronautics Co., Huntington Beach, Calif. Prime contractor for the Palapa spacecraft is Hughes Aircraft Co., El Segundo, Calif.

(END OF GENERAL RELEASE. BACKGROUND INFORMATION FOLLOWS.)

DELTA LAUNCH VEHICLE

First Stage

The first stage is a McDonnell Douglas modified Thor booster incorporating nine strap-on Thiokol solid-fuel rocket motors. The booster is powered by a Rocketdyne engine using liquid oxygen and liquid hydrocarbon propellants. The main engine is gimbal-mounted to provide pitch and yaw control from liftoff to main engine cutoff (MECO).

Second Stage

The second stage is powered by a TRW liquid-fuel, pressure-fed engine that also is gimbal-mounted to provide pitch and yaw control through the second stage burn. A nitrogen gas system uses eight fixed nozzles for roll control during powered and coast flight, as well as pitch and yaw control during coast and after second stage cutoffs. Two fixed nozzles, fed by the propellant tank, helium pressurization system, provide retrothrust after third stage separation. Fifty-two minutes after spacecraft separation, the second stage will be reignited for a 16-second burn. Data on this burn will be collected for studies related to future Delta missions.

Third Stage

The third stage is the TE-364-4 spin-stabilized, solid propellant Thiokol motor. It is secured in the spin table mounted to the second stage. The firing of eight solid propellant rockets fixed to the spin table accomplishes spin-up of the third stage spacecraft assembly.

Injection Into Synchronous Orbit

The Delta vehicle will inject Palapa into a transfer orbit having an apogee of 36,300 km (22,570 mi.). At this point, NASA/Delta responsibilities end. Command, control, tracking and data analysis become the responsibilities of the Western Union Control Stations and Jakarta.

TYPICAL LAUNCH SEQUENCE FOR PALAPA-B

Event	Time	Altitude Kilometers	Altitude Miles	Velocity Km/hr	Velocity Mph
Liftoff	0 sec.	0	0	2,434	1,512
Six Solid Motor Burnout	38 sec.	6	4	2,358	1,467
Three Solid Motor Ignition	39 sec.	6	4	2,358	1,467
Three Solid Motor Burnout	1 min. 18 sec.	23	14	3,960	2,460
Nine Solid Motor Jettison	1 min. 27 sec.	24	15	4,266	2,650
Main Engine Cutoff (MECO)	3 min. 48 sec.	106	65	18,702	11,620
First/Second Stage Separation	3 min. 56 sec.	113	70	18,720	11,632
Second Stage Ignition	4 min. 1 sec.	116	72	19,782	12,292
Fairing Jettison	4 min. 35 sec.	137	85	19,260	11,967
Second Stage Cutoff (SECO)	8 min. 55 sec.	188	117	28,222	17,536
Third Stage Spinup	22 min. 36 sec.	231	143	27,893	17,332

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TYPICAL LAUNCH SEQUENCE FOR PALAPA-B (Cont'd.)

Event	Time	Altitude Kilometers	Altitude Miles	Velocity Km/hr	Velocity Mph
Second/Third Stage Separation	22 min. 38 sec.	231	143	27,893	17,332
Third Stage Ignition	23 min. 20 sec.	231	143	27,893	17,332
Third Stage Burnout	24 min. 3 sec.	233	145	36,797	22,864
Third Stage/Spacecraft Separation	25 min. 15 sec.	259	161	36,710	22,811
*Second Stage Ignition #2	77 min. 24 sec.				
Second Stage Cutoff (SECO 2)	77 min. 26 sec.				

*Experimental Burn for R&D Purposes. Not mission-related.

-more-

LAUNCH OPERATIONS

Kennedy Space Center's Expendable Vehicles Directorate plays a key role in the preparation and launch of the thrust-augmented Delta rocket carrying Palapa-B.

Delta 129 will be launched from Pad A at Complex 17, Cape Canaveral Air Force Station.

The Delta first stage and interstage were erected on Pad A Jan. 11. The nine solid strap-on rocket motors were mounted in place around the base of the first stage Jan. 13 and 14 and the second stage was erected Jan. 21.

The Palapa-B spacecraft was received early in February, checked out and mated with the Delta third stage. The staged spacecraft assembly is to be mated with Delta on March 3 and the payload fairing which will protect the spacecraft on its flight through the atmosphere is to be put in place March 8.

DELTA/PALAPA LAUNCH TEAM

NASA Headquarters

John F. Yardley	Associate Administrator for Space Flight
Joseph B. Mahon	Director of Expendable Launch Vehicle Programs
Peter T. Eaton	Manager, Delta Program

Goddard Space Flight Center

Dr. Robert S. Cooper	Director
Robert E. Smylie	Deputy Director
Dr. William C. Schneider	Director of Projects Management
Charles R. Gunn	Delta Project Manager
William R. Russell	Deputy Delta Project Manager, Technical

Goddard Center (cont'd.)

Robert Goss	Chief, Mission Analysis and Integration Branch, Delta Project Office
William Burrowbridge	Delta Mission Integration Engineer
Tecwyn Roberts	Director of Networks
Albert G. Ferris	Director of Mission and Data Operations
Richard Sclafford	Network Support Manager
Dale Call	Network Director
John Walker	Network Operations Manager
Wayne Murray	Network Operations Manager
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Kennedy Space Center

Lee R. Scherer	Director
Miles Ross	Deputy Director
Dr. Walter J. Kapryan	Director, Space Vehicles Operations
George F. Page	Director, Expendable Vehicles
Hugh A. Weston, Jr.	Chief, Delta Operations Division
Wayne L. McCall	Chief Engineer, Delta Operations
Lawrence F. Kruse	Spacecraft Coordinator

-end-

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ADA-3

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RELEASE NO: 77-24

VIKING SET TO DIG DEEPLY

Commands have been sent to the Viking 1 lander on Mars to begin operations to dig a foot-deep trench in the soil and distribute samples to three instruments.

The trench--the deepest yet--is being dug to help Viking biologists understand the complex soil chemistry, and to see if large amounts of oxygen that were observed in surface samples also occur at depth.

- more -

Mailed:
February 13, 1977

Commands were sent (Thursday, Feb. 10) from NASA's Jet Propulsion Laboratory to Viking Lander 1 to begin its deep-digging operations on Saturday, Feb. 12. The sequence will continue through March 15 and will include a series of pictures taken by the lander to show mission controllers how it is progressing.

On March 13, the first sample from the deep trench will be placed in the inorganic soil-analysis experiment.

The final sample, from the bottom of the trench, will be placed in the biology instrument's gas-exchange experiment in early April, according to current plans.

A shallower trench will be dug by Viking Lander 2. The operations began with an attempt to build a rock pile that would have been placed in the inorganic soil analysis instrument. However, scientists were unable to find any pebbles and have concluded that the area where the dig took place has only fine materials and lightly cemented soil grains.

During the Lander 2 digging sequence, a soil sample will be taken for the inorganic experiments on Feb. 16. Another attempt will be made to build a rock pile on Feb. 27. A sample for the inorganic experiment will be taken March 12 and 13.

The final sample from the bottom of the trench will be placed in Lander 2's biology instrument about March 28 and 29, according to present plans. That sample will be distributed to Lander 2's labeled release and carbon assimilation experiments within the biology package and will be used for a closed cold incubation sequence.

Meanwhile, Viking Orbiter 1 continued to close in on the Martian satellite Phobos for a series of close passes. The sequence will begin Feb. 18 and continue through Feb. 24. The closest pass--at a distance of about 80 kilometers (50 miles)--will occur Feb. 23. A total of 11 close passes at Phobos are planned.

- more -

In addition to a series of photographs of the small satellite, scientists will closely measure Phobos' temperature and will observe how its gravity deflects the course of the spacecraft. These measurements and the pictures should help determine Phobos' composition and provide some clues to its history and that of the solar system.

After completion of the Phobos encounters, mission planners will alter the orbit of Viking Orbiter 1, dropping its closest approach to Mars to about 300 km (185 mi.) from the present closest-approach altitude of 1,500 km (950 mi.).

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HDA-3

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For Release:
IMMEDIATE

RELEASE NO: 77-25

MISSISSIPPI RIVER TO BE MONITORED BY SATELLITE

Even Mark Twain, with all of his boyish imagination, would have been astonished to see "his" river measured and watched by a gadget called a satellite 22,300 miles up in space.

Although it's too late for the folks of Mark Twain's day, a new system developed by NASA in cooperation with the U.S. Army Corps of Engineers, will be just in time to monitor the great Mississippi River from St. Louis, Mo., to the Gulf of Mexico this spring.

The system using "off the shelf" space technology, was developed and demonstrated for the Corps of Engineers at NASA's National Space Technology Laborоratories, Bay St. Louis, Miss. It is called a Geostationary Operational Environmental Satellite (GOES) Data Acquisition System.

- more -

Mailed:
February 16, 1977

Water Data Transmitters (WDTs) have been placed at stategic locations along the Mississippi River, at water control structures and on principal tributaries in the middle and lower Mississippi River valley.

These remote instruments take vital measurements such as river and reservoir water level, rainfall and water quality...and communicate the data via the National Oceanic and Atmospheric Administration (NOAA) GOES-1 satellite to a central ground receiving site. There, the information is converted to usable engineering units, stored in a computer and displayed immediately on a board. The vast quantities of data are applied in computer models to aid the water control decision-making process. Water control managers will be able to observe the board, to see in "real time" what the giant Mississippi River is doing. This information will assist the Corps of Engineers managers to act on levee reinforcement and to respond to flood situations quicker and more efficiently than in the past.

The system was developed by NASA at the request of the Corps of Engineers Lower Mississippi Valley Division. NASA engineers and technicians have just completed checking out the system at the NSTL laboratories near Bay St. Louis, Miss., and demonstrating that it is operational, before turning it over to the Corps.

The signals are now coming from 20 of the stationary WDTs or "river black boxes" via satellite to an antenna at NSTL, recorded and displayed during this checkout phase. There will be 80 stations in the automated data collection system initially.

The system was officially turned over to the Corps of Engineers this week and will be moved and installed in the River and Reservoir Control Center in the Lower Mississippi Valley Division office in Vickburg, Miss.

Although Corps officials say information gathered rapidly for real time use has already proven valuable, the real worth of the system will be to help monitor and manage the great river on a continuing basis year around, especially during floods and droughts.

Quick and accurate information will allow the Corps to assist federal, state and local governments, river traffic, industry and farmers, and anyone who is affected by the waters of the Mississippi in matters relating to the vast water resource of the lower Mississippi River valley, including the Atchafalaya River Basin in southern Louisiana.

The project was initiated in 1975 after many discussions between NASA and Corps personnel on the transfer and demonstration of this space technology.

Initial development of this technology occurred during the Nimbus and Application Technology Satellite programs of NASA.

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AAA-3

For Release:

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IMMEDIATE

RELEASE NO: 77-26

INVESTIGATORS SELECTED FOR FIRST SPACELAB FLIGHT

Two hundred and twenty-two scientists, representing the United States and 14 other countries, have been selected to participate in the first Spacelab flight in 1980.

The group was chosen by NASA and the European Space Agency (ESA) from more than 2,000 candidates who responded to invitations to participate in the jointly planned NASA/ESA mission.

Scheduled to be launched into Earth orbit aboard NASA's Space Shuttle in the second half of 1980, the European-built Spacelab is designed to allow workers to live and to perform experiments in space economically and frequently.

-more-

Mailed:
February 16, 1977

The primary objective of the first flight is to verify the performance of Spacelab systems and subsystems, and to measure the environment surrounding the Shuttle.

The secondary objective is to obtain valuable scientific, applications and technology data and to demonstrate the broad capability of Spacelab to perform space research. Stratospheric and upper atmosphere research will be emphasized on this flight, but experiments also will be performed in plasma physics, biology, botany, medicine, astronomy, solar physics and Earth observations and in technology areas such as thermodynamics, materials processing and lubrication.

Spacelab 1, a reusable laboratory, will consist of two main elements, a pressurized module and a pallet. The pressurized module is the laboratory where the scientists will work. It will have a shirtsleeve environment to make work as pleasant and as nearly like that of an Earth-based laboratory as possible. For instruments that require exposure to space, Spacelab provides a series of pallet segments in the payload bay. In addition to serving as a mounting platform, pallets provide power, thermal conditioning, data and other services to the instruments. Spacelab 1 will have one pallet, but as many as five may be flown at one time.

Spacelab 1 will be launched from the Eastern Test Range, Cape Canaveral, Fla., and will remain in Shuttle Orbiter's cargo bay as it orbits the Earth at an altitude of about 250 kilometers (155 miles), with an inclination of 57 degrees. The flight will last one week.

After the Shuttle Orbiter reaches its proper orbit, the necessary Spacelab systems will be activated and tested. Then the payload specialists,working with the Orbiter crew and the scientific and technical investigators on the ground, will perform various experiments until the Spacelab systems are shut down in preparation for returning to the landing site. The two payload specialists, an American and a European, will work complementary shifts so that scientific experimentation can continue 24 hours a day.

Of the 86 investigators chosen by NASA, 81 are from the United States and the others are from India, Japan, Canada, France and Belgium. The remaining 136 scientists selected by ESA come from 10 ESA member states, plus Austria and Norway.

The Solar Terrestrial Division in NASA's Office of Space Science has overall management responsibility for the NASA Spacelab 1 payload. B. G. Noblitt is the Program Manager and W. W. L. Taylor is Program Scientist. Marshall Space Flight Center, Huntsville, Ala., has been assigned Project Management responsibility for Spacelab 1, with R. E. Pace as Mission Manager. C. R. Chappell is the Mission Scientist. Responsibility for the ESA payload for Spacelab 1 has been assigned by ESA to its Office of Spacelab Payload Integration and Coordination in Europe (SPICE) at Porz-Wahn, West Germany.

The Principal Investigators selected by NASA and their research areas are as follows:

M. R. Torr - University of Michigan
Atmospheric Sciences

S. B. Mende - Lockheed Palo Alto Research Laboratories
Atmospheric Sciences

T. Obayashi - University of Tokyo
Atmospheric and Plasma Physics

S. Biswas - Tata Institute of Fundamental Research (India)
Cosmic Ray Physics

C. S. Bowyer - University of California (Berkeley)
Ultraviolet Astronomy

L. R. Young - Massachusetts Institute of Technology
Vestibular Studies

M. F. Reschke - NASA, Johnson Space Center
Vestibular Studies

S. L. Kimsey - NASA, Johnson Space Center
Blood Kinetics

E. W. Voss - University of Illinois
Immune Responses

F. M. Sulzman - Harvard Medical School
Circadian Rhythms

A. H. Brown - University of Pennsylvania
Plant Growth Studies

E. V. Benton - University of San Francisco
High Energy Particle Dosimetry

J. Hart - University of Colorado
Atmospheric Sciences

C. H. T. Pan - Shaker Research Corporation
Lubrication

K. E. Demorest - NASA, Marshall Space Flight Center
Tribology

C. B. Farmer - NASA, Jet Propulsion Laboratory
Atmospheric Sciences

R. C. Willson - NASA, Jet Propulsion Laboratory
Radiation Measurement

Investigators have been selected by ESA for the following studies aboard Spacelab 1:

Atmospheric Physics

Composition Measurements with a Grille Spectrometer
Infrared Photography to Study Upper Atmospheric Waves
Interferometric Temperature and Wind Measurements
Photometry of Lyman Alpha Emissions
Solar Spectrum from 1900.19 to 4 Microns

Plasma Physics

Measurements of Low Energy Electrons
Phenomena Induced by Charged Particle Beams

Solar Physics

Solar Constant Measurement

Astronomy

UV Astronomical Observations
X-ray Spectroscopy
Heavy Cosmic Ray Isotopes

Life Sciences

Vestibular Studies
Mass Discrimination
Measurement of Intrathoraxic Blood Pressure
Lymphocyte Proliferation
Penetrating Radiation Studies
Biological Effects of Hard Radiation
Three Dimensional Ballistocardiography
Electrophysiological Tape Recorder
Hormonal Measurements in the Space Environment

-more-

Material Sciences

Isothermal Furnace
Low Temperature Gradient Furnace
Mirror Furnace
High Temperature Gradient Furnace
Fluid Physics Module
Miscellaneous Material Science Investigations

Earth Observations

Cartography
Microwave Scatterometer--Radiometer

Measurements of the Shuttle/Spacelab Environment

Magnetic Field Measurements

- end -

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For Release:

IMMEDIATE

RELEASE NO: 77-27

NASA CONTRACTS FOR WORLD'S LARGEST WINDMILL BLADE

NASA's Lewis Research Center, Cleveland, Ohio, acting as project manager for the Energy Research and Development Administration (ERDA), has named Kaman Aerospace Corp. of Bloomfield, Conn., to build the world's largest windmill blade.

The 15-story blade will be constructed primarily of glass fiber, using techniques derived from those applied to buld helicopter rotors. It will weigh about 19,400 kilograms (17 tons).

At 45.7 meters (150 feet), the blade will be more than twice the length of the 19 m (62.5 ft.) blades which power the 100-kilowatt wind turbine generator now in use at Lewis Research Center's Plum Brook Station in Sandusky, Ohio.

- more -

Mailed:
February 17, 1977

The largest windmill on record was built before World War II on Grandpa's Knob at Rutland, Vt. In winds of 50 kilometers per hour (30 miles per hour) or more, it could generate 1.25 megawatts of electricity with its 26.5 m (87.5 ft.) blades. The wind generator ceased operating in 1945 when one of the blades broke off near the hub.

The $2 million contract with Kaman Aerospace will pay for designing, fabricating, testing and evaluating the giant turbine rotor blade, which is to be representative of the type of blades needed for production windmills generating 1.5 megawatts of electricity--enough for several hundred homes.

The contract allows for the expensive tooling necessary to build the single blade and for the technological development required to fabricate such blades for future production. The largest helicopter blade now in use is only about a third as long--16.7 m (55 ft.).

- more -

Detailed design studies will also begin this year on 2 megawatt wind turbines. Two of the 47.5 m (150 ft.) blades would be needed to power a 2-megawatt wind turbine in average winds of 22 km/h (14 mp/h). NASA and ERDA will use these studies to determine the future test program for blades this size.

ERDA is pursuing development of giant wind turbines as a result of studies showing that the larger machines can produce electricity at a lower cost per kilowatt. General Electric Co. is designing and building two 1.5-megawatt wind machines to be installed and tested for NASA and ERDA in 1978-80.

- end -

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RELEASE NO: 77-28

SOUNDING ROCKETS WILL STUDY MYSTERIOUS CELESTIAL OBJECTS

Some of the most mysterious astronomical objects in the universe will be among the observation targets of six NASA rockets launched from Australia this month.

Instruments will be carried aloft from the Woomera Range in Australia during the week of Feb. 16-24 aboard 10-meter (32-foot)-long Aerobee sounding rockets to investigate X-ray stars, hot stars, white dwarfs and exploding galaxies.

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NASA's Goddard Space Flight Center, Greenbelt, Md., is conducting the project in cooperation with the Australian government, the University of Adelaide and several U.S. universities and scientists. The Goddard project manager is Richard M. Windsor.

The investigations are as follows:

- One of the studies, conducted by Columbia University, involves "bursters" or bursting X-ray stars. These sources emit powerful bursts of energy, observed in the X-ray part of the electromagnetic spectrum, which were extensively observed by NASA's Small Astronomy Satellite-3 (SAS-3) last year. Although there has been much speculation, no one knows what they are. Dr. Richard Wolff of Columbia University's Astrophysics Laboratory says these intense and unusual X-ray sources release energy bursts a million times greater than that coming from our Sun in the same time period. So far the bursts have been measured in seconds. Dr. Wolff wants to find out if they also emit energy in milliseconds at irregular intervals. If so, this could mean they are "black holes," celestial objects with such density that not even light rays can escape.

A teaspoon of material from such an object would weigh as much as New York. If they are neutron stars, which are extremely dense gravitationally-collapsed stars believed to be the result of super-novae, they will have regular rotation rates and emit signals measured in seconds. SAS-3 does not have the sensitivity to differentiate between the two types of signals.

- Dr. Gilbert Fritz, of the U.S. Naval Research Laboratory will be flying X-ray astronomy payloads in two rockets. He will be looking at the Large Magellanic Cloud and the Coma Cluster of galaxies. In observing the Magellanic cloud, he will look for new X-ray stars in order to compare their distribution, luminosity, temperatures and periodic or random X-ray fluctuation, with stars in our own galaxy.

There are millions of stars in what is called The Bar, a cigar-shaped swarm of stars at the center of the Large Magellanic Cloud where an X-ray source has been reported. Dr. Fritz's observations will determine whether the Magellanic Cloud is similar to our own galaxy, which has several X-ray sources very close to the galactic nucleus where star density is high.

Some scientific theories of these X-ray sources are associated with either large numbers of neutron stars or an immense black hole.

- A second NRL payload will scan the Coma Cluster of galaxies, a well-known X-ray source, to build up an X-ray picture of the cluster. The X-ray picture will enable scientists to test theoretical models of the origin of the hot (100 million degrees Kelvin) intergalactic gas producing the X-rays.

- Dr. Warren Moos of Johns Hopkins University will be looking at nearby Alpha Centauri and other stars similar to our Sun. Alpha Centauri-A, four and a half light years away, is called the twin of our Sun and is believed to be about twice its age. Dr. Moos will look for evidence of a corona in far ultraviolet light. None has ever been seen. The results of this observation may give us a better idea of what our Sun will be like in the future.

- Another Johns Hopkins investigator, Dr. Paul Feldman, will be flying instrumentation designed to make accurate ultraviolet measurements of early type or hot stars. These stars will be used for inflight calibration of satellite-borne ultraviolet telescopes.

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An extreme ultraviolet instrument will also look at emissions from white dwarf companion stars in binary systems. White dwarfs are the end product of evolution for most stars of low mass.

- A Goddard scientist, Dr. Andrew M. Smith, will be looking at the Large Magellanic Cloud with a Schwarzschild camera equipeed with ultraviolet filters. He will be studying the distribution of hot stars, young supernovae remnants, galactic dust, high-energy gas and other celestial phenomena.

The Aerobee has been a U.S. launch vehicle since 1947, having launched nearly 1,000 scientific payloads. It is capable of lifting a 181-kilogram (400-pound) payload to an altitude of 210 kilometers (130 miles).

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RELEASE NO: 77-29

MCDONNELL DOUGLAS TO MARKET SHUTTLE UPPER STAGE FOR HEAVY PAYLOADS

NASA and the McDonnell Douglas Corp., Huntington Beach, Calif., have signed an agreement under which as a commercial venture the company will design, manufacture and test a solid-propellant upper stage system, including integration services, to be used on Space Shuttle missions for heavy Atlas-Centaur class payloads.

The agreement, similar to one between the company and NASA reached late last year, provides for an upper stage that would handle payloads weighing up to 2,000 kilograms (4,400 pounds).

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After insertion into low Earth orbit by the Shuttle, the upper stage would carry payloads into a transfer orbit where a kick motor would insert it into a circular, geosynchronous orbit 35,900 kilometers (22,300 miles) above the Earth. The earlier agreement concerned an upper stage capable of handling payloads up to 1,100 kg (2,450 lb.).

The new agreement covers payloads of a size now being launched using Atlas Centaur rockets while the previous agreement covers lighter payloads of a size now being placed in orbit by Delta launch vehicles. The stages are called SSUS-A (for Spinning Solid Upper Stage-Atlas Centaur class) and SSUS-D (for Delta class).

McDonnell Douglas may sell these stages and services either directly to users or to NASA. The company will meet the NASA schedule for Space Shuttle operations so that NASA's assurances to Space Shuttle users will be met.

The Space Shuttle is a reusable space vehicle that is launched like a rocket and lands after its mission on a runway like an airplane. When it becomes operational in 1980 it will replace most of NASA's expendable launch vehicles such as the Atlas-Centaur and Delta. The Space Shuttle is designed so that it may be refurbished and prepared for another flight two weeks after landing.

The space agency plans to procure SSUS-A systems only from firms with which it has a commercial agreement. Firms which reach agreement with NASA will be free to sell their stages to customers directly or to NASA.

The agreements specify performance requirements, define a schedule for development establish unit ceiling prices and a ceiling profit.

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For Release:
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RELEASE NO: 77-30

NASA AVIATION SAFETY REPORTING CITED FOR IMPROVED QUALITY

An increase in the quality of reporting marked the second quarter operations of the NASA Aviation Safety Reporting System (ASRS). Over half of the 1497 reports received, dealing with air operations problems nationwide, included unsolicited recommendations toward solution of a variety of air traffic problems, offered by persons submitting the documents.

NASA commented in its second quarterly report for the period ending October 14 that much thought and effort went into preparation of these voluntary reports.

The NASA ASRS is part of the FAA Aviation Safety Reporting Program. The program enables the FAA and others to take positive action to increase the safety of the National Aviation System.

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February 25, 1977

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Designed as an early warning system, ASRS reports are voluntarily submitted to NASA by pilots, air traffic controllers and others in the National Aviation system. Fifty-eight Alert Bulletins were prepared and submitted by the NASA to the FAA during this report period.

During the first and second quarters the volume of reports to the ASRS remained relatively constant, with an average of 100 reports being received each week. Reports from pilots declined slightly during the second quarter. Controller reports now comprise half rather than one-third of the total volume.

The NASA quarterly report noted that at least three-fourths of all reports involved incidents in controlled airspace and that some type of flight plan had been filed in 84 per cent of the flights described.

All ASRS reports received during the second quarter were initially screened by NASA personnel. They were then processed with names of persons reporting removed and were analyzed by the professional staff of Battelle's Columbus Division at its ASRS Office in Mountain View, Calif.

During this process, attempts were made to augment the information contained in 340 reports by telephone contact with the reporter. These attempts were successful in 270 cases. Eighty per cent of the reports submitted were reviewed within 2 working days with names of persons reporting removed to protect their right of free comment without fear of reprisals.

The NASA ASRS Second Quarterly Report, NASA TM X-3494, can be obtained from the National Technical Information Service, Springfield, Va., 22161 for $4.25.

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RELEASE NO: 77-31

ULTRA-THIN SOLAR CELLS TO REDUCE WEIGHT OF SPACE ARRAYS

NASA has announced the development of large-area, ultra-thin silicon solar cells to increase the power-to-weight capability of solar arrays in space. The new cells are thinner than a sheet of newspaper.

This technology breakthrough is a major step toward enabling solar energy to be used in space for applications requiring multi-kilowatts -- even millions of watts -- of electrical power, NASA officials reported.

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The thin cells were developed by the Solarex Corp., Rockville, Md., under the sponsorship of NASA's Office of Aeronautics and Space Technology (OAST). Hundreds of four-centimeter-square thin cells have been manufactured and delivered by Solarex to the NASA Jet Propulsion Laboratory (JPL), Pasadena, Calif., for test, evaluation and design application studies.

The cells are 40 to 50 microns -- about 2/1000th of an inch -- thick, only one-sixth of the 300-micron thickness used in present spacecraft solar arrays. (A micron is 1/25,000th of an inch.)

Ultra-lightweight thin cells will permit development of larger solar arrays, producing multi-kilowatt electrical power for ion propulsion systems for extended space exploration. They would also provide the potential for powering platforms and perhaps remote satellite power stations in the future.

A second firm, Spectrolab, Inc., Sylmar, Calif., also has begun to manufacture and deliver the thin cells to JPL.

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Solarex has manufactured the cells in sizes up to 38 centimeters square. The cells have been demonstrated to be structurally flexible and less fragile than their thinness would imply, overcoming a major concern during development. The energy conversion efficiency of the new cells is virtually equal to that of the conventional 300-micron thick cells now in general use (11 per cent for the thin, versus 12-13 per cent for the thick).

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RELEASE NO: 77-33

DESIGN PROPOSALS SOUGHT FOR INFRARED SATELLITE

NASA has invited industry to submit proposals for the design and manufacture of an international Infrared Astronomy Satellite (IRAS).

The project was recently approved by the United States and the Netherlands, with the Jet Propulsion Laboratory, Pasadena, Calif., assigned to manage the U.S. portion.

Proposals are due by March 1, leading to selection of a contractor later this year.

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Scheduled for launch in March 1981, the Earth-orbiting observatory will employ a telescope furnished by the U.S., a spacecraft built by the Netherlands and a control facility supplied by the United Kingdom.

The Explorer-class satellite will be launched from the Western Launch Operations Division at Lompoc, Calif., and placed in a 900-kilometer (563-mile) polar orbit.

JPL, in addition to its project management role, will design and operate the scientific analysis facility which will produce an infrared sky map and source catalogue, containing as many as 1 million infrared sources. NASA's Ames Research Center, Mountain View, Calif., is responsible for the large 60-cm (24-in.) aperture infrared telescopes.

The IRAS project, involving nearly 500 scientists, engineers and technicians of the three nations, will survey the entire sky for one year at those infrared wavelengths undetectable by Earth-based telescopes because of the obscuring effects of the atmosphere.

The infrared region of the electromagnetic spectrum is among the least explored. Yet early investigations have. produced discoveries which suggest that this spectral region is extremely important to a clear understanding of the nature of the cosmos. For example, observation of background radiation in the infrared is linked to the Big Bang theory of the origin of the universe. A shell of expanding infrared radiation was theorized and then detected several years ago, and is thought to be evidence of the explosion of the primeval fireball 18 billion years ago that contained all the matter in today's universe.

With IRAS, observations in the infrared will permit studies of stars both in the process of forming and at the end of their life cycle.

The NASA program manager is Leon Dondey. Kane Casani has been named project manager by JPL. George Aumann of JPL is project scientist. Nancy Boggess is program scientist.

The IR telescope construction will be managed at Ames by Tom Harmount. Prof. Gerry Neugebauer of the California Institute of Technology heads the U.S. scientific team which will work with Dutch and British scientists. Caltech operates JPL for NASA.

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RELEASE NO: 77-34

HUGHES NAMED TO PRODUCE THEMATIC MAPPER INSTRUMENT

NASA has selected the Hughes Aircraft Co., Space and Communications Group, El Segundo, Calif., for negotiation of a contract for a Thematic Mapper Instrument to be installed on Landsat-D scheduled for launch in early 1981. Landsat-D will be the fourth in a series of Earth Resources Technology satellites.

The basic contract will be for instrument design, development, fabrications, assembly, test, and qualification of hardware which includes the prototype flight model and one set of bench test and calibration equipment and support services. Two options will be included in the basic contract: Option one will include an additional flight unit, an additional set of bench test and calibration equipment, and support services. Option two will include two additional flight units and support services.

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The contract type will be cost-plus-award-fee. The contractor's proposed costs for the basic effort and options one and two, are approximately $27,500,000, $10,200,000 and $16,000,000. Completion and delivery of the prototype flight model is expected during the last half of 1980.

The Thematic Mapper will be an advanced remote sensing instrument capable of providing improved measurement techniques for land resources management. Specifically, the instrument will contribute to improvements in fore-casting yields of all major crops, local crop productivity, agricultural land use, forest resources management and range management. Thematic Mapper data will also be useful for improvements in water resources management, land use mapping and mineral exploration.

The accomplishment of these objectives requires making observations with repetitive temporal coverage and delivering information to appropriate users with improved spatial and spectral resolution and of suitable accuracy to permit assembling "thematic" maps at a 1:250,000 scale of a scene format of approximately 185 x 185 kilometers (115 x 115 miles) compared to 1:1,000,000 for the present Landsat satellite .

The ground resolution capability of the Thematic Mapper will be about 30 meters (100 feet) from an altitude of approximately 700 km (440 mi.) and will scan the Earth in six spectral bands. Landsats I and II have an 80 m (265 ft.) resolution and four spectral bands.

The Thematic Mapper program will be managed by the Goddard Space Flight Center, Greenbelt, Md.

TRW, Inc., of Redondo Beach, Calif., also competed for this procurement.

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FEBRUARY 1977

DOWN TO EARTH --

A WOMAN'S VIEW OF SPACE

BY

LILLIAN LEVY

SOLAR ENERGY -- AN INAUGURAL FIRST!

(The first of a two-part series on collecting energy from the Sun for heating purposes on Earth)

On Jan. 20, 1977, this nation's 39th President, Jimmy Carter, reviewed the inaugural parade from a stand with a solar heating system prepared under the direction of Dr. Stan Bailey and Dr. Jim Craig from the Department of Aerospace Engineering of Georgia Institute of Technology's College of Engineering in Atlanta. This experiment in solar heating, the first ever undertaken to heat a Presidential viewing stand, underscores President Carter's keen interest in exploring and testing different sources of energy for this nation's growing needs.

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Did it work; and if so, how well?

According to Bailey, the system worked, but not at its optimum level.

"The system did supply solar energy to heat the Presidential inaugural stand," he said, "but its efficiency was hampered by unexpectedly severe and sustained cold weather as well as by the constraints imposed by architectural design of the stand and subsequent restrictions on the placement of the solar units for the system."

Temperatures in the nation's capital on the day of the inauguration were unusually low, ranging from 20 to 33 degrees F. In addition, the Presidential inaugural stand had openings at the corners about seven feet wide and nine feet high and the space above the glass front of the stand was open to the air.

"As a result," Bailey said, "wind and cold air could and did flow directly into the stand; and the system, in effect, was called upon to work to heat up the great outdoors as it invaded the semi-enclosed stand."

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Originally positioned to be adjacent to the stand and at an angle to get optimum Sun the system and its solar units or collectors were moved to make way for a special White House mobile unit. As a result, the collectors were partially shaded.

"The collectors will not 'turn on' if the Sun does not strike the sensors," Bailey explained. "The move exposed the system to shade from the mobile unit and trees and, as a result, its efficiency was reduced by as much as 40 per cent."

Solar rays did strike the collectors, however, and the system collected enough energy to heat the water flowing through thin pipes placed back of the seats on the viewing stand. Water circulated through the solar collectors into the stand was heated by solar energy and an auxiliary backup, an electric water heater, subsequently was used to boost the temperature of the water in the pipes to over 180 degrees F.

With sunlight hitting all the solar units, there would have been no need for the auxiliary system, Bailey said. Incidentally, the system for the Presidential stand was designed only to take the chill out of the air and was never intended to provide 60 degrees to 70 degrees F. temperatures.

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An examination of the solar units, before the President and his party entered the inaugural stand, showed that there was a good heat flow. The pipes were hot and heat flowed from them to the nearby surrounding area. Had there been a linkage with a forced air system, the heat could have been discharged more effectively.

"However, it should be made clear that the solar heating system did work," Bailey said.

Such a system has potential for use in way stations for bus stops, for example, or for hot water systems and the same collectors, used for an enclosed environment such as a home or office building, would provide sufficient heat and hot water for comfort. Indeed, similar collectors are used today for solar energy systems that function effectively for homes, offices and public buildings. The use and cost of such systems will be discussed in the second and last article of this two-part series.

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DOWN TO EARTH--

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LILLIAN LEVY

REACHING FOR THE SUN

(The second of a two-part series on collecting energy from the Sun for use on Earth)

The cold spell this past month and the shortages of natural gas as well as the need to import foreign oil in steadily larger amounts underscores the necessity for this nation to develop other energy resources. One of the most abundant and most visible is the Sun and NASA is reaching for the Sun to develop solar heating and cooling systems for residential and commercial use.

At NASA's Marshall Space Flight Center in Huntsville, Ala., solar collectors have been developed from technology gained from Apollo and Skylab programs for which the Sun was an important source of energy.

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At the center there is an ongoing "Solar House" project, in operation since June 1975, and the data and knowledge gained from that project is available for use by business, **and industry, as well as by other investigators** from research centers and universities now concentrating on solar energy for home, commercial and even recreational use.

But one of the major questions about solar heating and cooling, whether for home, office or recreation, is the question of cost. Are such systems economically feasible? Do they cost more than conventional systems?

The answer to both questions is "Yes." They cost considerably more, but they are definitely economically feasible, according to Dean Richard Williams of Georgia Institute of Technology's College of Engineering in Atlanta.

In support of this judgment for solar power, Dean Williams points to the just completed Shenandoah Solar Community Center in Atlanta, Ga., a project of his college, funded by a Federal grant.

The center encompasses 55,000 square feet and it is heated 95 per cent by solar energy. Solar power also provides energy for air conditioning -- but only up to 64 per cent.

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An auxiliary system provides the backup needed for the air conditioning. The operation of the center is a real plus for solar power; but the cost also is plus -- plus $700,000 over the cost of a conventional heating and air conditioning system.

However, under a conventional system, the cost of fuel would be an additional $70,000 annually at the present price of oil. And that can go up. There is no cost for the energy from the Sun. That means that in 10 years, the solar system will have paid for itself and from then on would provide heating and cooling at practically no cost at all.

There is no question but that at the present time the initial investment in solar power is costly; but the present high price for solar collectors and other apparatus needed to harness the energy of the Sun ultimately will be reduced as more and more collectors and other solar machinery are developed and used. Dean Williams predicted.

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The collectors used for the Center, incidentally, are covered with two layers of glass that has low iron content. The lower level of iron in the glass makes it far more translucent and thus improves the efficiency of the solar collectors. In fact, according to Dean Williams, the collectors used to heat the Shenandoah Center can provide hot water at 140 degrees F., even when the temperature outside is minus 30 degrees F. and with the Sun as an energy source, there is no cost for "fuel."

We should use the power of the Sun as much as possible. Dean Williams believes -- especially since the cost of investment in collectors and other parts of a solar heating and cooling system is a one-time thing. NASA studies tend to support his endorsement of solar power.

If you are a homeowner, it might be wise to try using solar power on a small scale first, perhaps by installing a solar system just for hot water. The flat-plate collectors for such a system are relatively low in cost and are worth investigating.

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DOWN TO EARTH --

A WOMAN'S VIEW OF SPACE

BY

LILLIAN LEVY

AN ANNIVERSARY AND AN ASSESSMENT

(Editors Note: On Feb. 20, 1962, former Mercury Astronaut John H. Glenn, now senior U.S. Senator from Ohio, became the first American to orbit Earth. In a broad-ranging interview on the 15th anniversary of his pioneer space ride in Mercury space capsule Friendship 7, he expressed his views on space exploration, assessing its present place and influence on our society and its potential for the future. This is the first of a two-part series on that assessment which discuss career opportunities as well as other by-products from our national space effort.)

Since Feb. 20, 1962, when John H. Glenn became the first American to orbit Earth, he has gone from space exploration to a career in business and now is politically active as the senior U.S. Senator from Ohio.

Though no longer a participant in our ventures in space, he is an interested and informed observer with some very definite ideas about exploration in the vertical frontier and what it holds for the future and these are revealed in the following interview.

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QUESTION: Much has happened in space and on Earth and to you since you orbited Earth 15 years ago. From a career in space exploration, you have gone to a political career. How do you view the potential for careers in space now?

GLENN: Well, I think our space program has been slowly expanding into broader opportunities for many vocations. We are just beginning to get into the time period of payoffs from our beginning efforts which concentrated largely on learning how to get into space and travel there. Basic research is the reason and objective for our space effort. It should be understood that the exploration of space was not undertaken to allow a few guys and/or gals, too, one of these days, just to go up and look around in the space environment. And as our efforts and projects in space continue, there will be ever broader opportunities for space-related careers.

Why?

The reason is that for every person on a space flight involved in a special research project, there are the many, many people on the ground needed for support--and not just to launch and retrieve passengers and payloads--but to put to use all the data gathered from space experiments.

We will need literally hundreds more scientists, technicians, programmers, analysts in all fields to put to constructive use all the data from space.

QUESTION: What kind of basic research are you talking about?

GLENN: I'm talking about basically three different areas of research.

First, there is energy research. Virtually all our energy comes originally from the Sun. If, as a result of research and travel in space, we can learn how best to collect and direct sunlight for our energy needs on Earth, we will have tapped an unlimited and clean source that will make us independent of other sources.

Looking in another direction, back to Earth, the Earth resources analysis program, provided by Landsat satellites, is probably the broadest gauge of all space research.

Through this effort, we are learning fantastic things about our own Earth. It enables us to monitor crops, discover new mineral deposits such as copper out West and oil domes in South America and, via satellite, we are finding water sources in the drought stricken Sahel region of Africa as well as monitoring pollution. I should also mention space communications,weather satellites and other scientific satellites that are providing data about our atmosphere and environment.

The third area has to do with what happens to the human body in the gravity free environment of space.

We have whole new approaches to cancer studies, high and low blood pressure and cardiovascular problems. New insights to problems in those areas have come out of the space program.

So it has been very valuable in those three particular areas: (1) looking out to the Sun for knowledge about energy that can be utilized here on Earth; (2) the analysis of Earth's resources through the Landsat satellites; and (3) the medical aspects of space.

QUESTION: In your remarks about the medical aspects of space research, you mentioned that human ventures into space may have provided insights into cancer. Could you elaborate on that?

GLENN: I understand that the National Institutes of Health has had some programs looking into this. You see, we don't know what triggers the body's changing cell replenishment program. In space, we discovered that the whole blood supply of the human body--the amount of blood--was altered drastically after people get beyond a four-day period in space.

Apparently the body senses that it no longer needs the same blood supply in the weightless space environment that it needs here in the one g gravity environment of Earth. We are a product of that force, one that was taken for granted until we were able to escape this force by entry into space and it is worth noting that even as recently as 1965 the term "weightlessness" could not be found in any medical textbook! But weightlessness is a condition of space and, in adapting to this new condition, tests show that the body adjusts by stopping the formation of new blood cells.

Why does this occur? Probably because in weightlessness blood does not pool in the legs and abdomen as occurs on Earth. In adapting to that fact of space living, some mechanism in the body turns cell replenishment off. If we can identify this mechanism, we may be able to find ways to turn off the runaway cell structure that is cancer. This is what the NIH researchers are investigating.

Space exploration, as I said earlier, is fundamentally a vast program of basic research--a search for knowledge; and while I have stressed only three research fields, there are many others. And perhaps it would be useful to go into some of these.

(In the next and last part of this two-part anniversary interview, Sen. John H. Glenn talks about the role of space satellites for education, women in space and the future.)

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DOWN TO EARTH --

A WOMAN'S VIEW OF SPACE

BY

LILLIAN LEVY

A DISCUSSION ON SPACE EXPLORATION--PRESENT AND FUTURE

BY THE FIRST AMERICAN TO ORBIT EARTH

(Editors note: On Feb. 20, 1962, former Mercury Astronaut John H. Glenn, now senior U.S. Senator from Ohio, became the first American to orbit Earth. In a broad-ranging interview on the 15th anniversary of his pioneer space ride in Mercury space capsule Friendship 7, he expresses his views on space exploration, assessing its present place and influence on our society and its potential for the future. This is the last of a two-part series on that interview.)

How does John H. Glenn, now the senior U.S. Senator from Ohio and the first American to orbit Earth, assess this nation's program of space exploration on the 15th anniversary of his history-making mission?

"It is," he said, "a fundamental and valuable search for knowledge whose benefits, large though they already are, will be even greater in the future."

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Among those benefits are space-related career opportunities for which education is essential. But while data and knowledge gained from space spur the need for more and better education, space technology, as Senator Glenn observed in the following interview, is making it possible to bring that needed education to remote regions on Earth where literacy is the exception rather than the rule.

QUESTION: Among the opportunities from space technology, there is one that you haven't mentioned yet. I refer to better education using space satellites.

GLENN: We haven't even scratched the surface yet of what can be done in that regard. I think the biggest project tried so far in education via satellite has been with India.

India never has had a nationwide school system. So what we did, in cooperation with India, was to develop a whole educational program and the means for getting it to all of India over a period of years. We put up a satellite in synchronous orbit with Earth, parked first over the Gallapagos Islands in the Pacific where it was used experimentally to bring educational programs into some of the most remote areas of Appalachia, the Rocky Mountains and Alaska, just to see how it worked.

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Using only one ground transmission station, linked to the satellite, instruction and lectures were sent to TV receivers directly--not through any TV program or network--but through direct linkage with a TV set on the ground. The experiment was a success.

The satellite was redirected by signals from the ground to a position to beam programs to India. In India, TV sets were put up at designated places all over the country in various communities. In each community, the set was the educational center. From a national central education system, instruction was sent to all designated community education centers in India at one time.

There are a lot of practical uses to be made of this kind of satellite using linkage with many individual ground communication centers. We are only just beginning to use such systems and to appreciate the value of such technology.

QUESTION: Looking ahead to 1992, the 30th anniversary of your orbital flight, do you foresee the beginning of colonies in space?

GLENN: I know it's popular to say, "Yes, we should go out and colonize the Moon, establish colonies in space;" but I don't really think its going to happen....not in that time period.

QUESTION: Why?

GLENN: Space travel and building for space still is extremely expensive. However, there is one thing that could alter any prediction about space and that is a new energy source. This is a development that I am sure will come along sometime. The question is when. But I am sure that we will find new energy sources and new ways of using them as we have throughout human history. Each new development has enlarged our capabilities with respect to where we can go and what we can do.

QUESTION: What other obstacles are there to early colonization of space?

GLENN: Scientists have talked for years about the nature of gravity and gravitational fields. Overcoming gravity for space flight by present means is costly. But what if we can learn to somehow negate gravitational fields or control their influence on a particular body such as a spacecraft?

There may be a way to play one gravitational field off against another and do it without the huge expenditure of the thousands of tons of fuel that now must be carried along. If this can be done, there's no limit to where we can go and what we can do in space--colonizing, manufacturing, anything. But unless we find ways to overcome gravity inexpensively, perhaps with an inexpensive new energy source, we will see a steady development in space exploration; but it will be slow. Also, the number of people who can go into space will be limited so long as we must depend upon present costly means of propulsion. The purpose of such travel probably will be limited as well to such basic research as we're gearing up for now with the Space Shuttle and the orbiting space station later on--probably in the late 1980s.

QUESTION: Having been in space, would you say it's a nice place to visit; but you'd rather live here?

GLENN: Well, if you go, you are definitely interested in making each visit a two-way trip--up and back, of course. I guess every place has its own attractions. Living here on Earth, it's nice to go into space, just as it's nice to go on trips to different parts of Earth and return home. And like all travel, whether on Earth or in space, it's a learning experience.

Of course, space travel is unusual and still rare. We're still really learning how to travel there and, in that context, space travel itself, as a basic research experience, is in its infancy. And as is the case with all basic research, no one can really predict what the ultimate outcome will be. If you knew the answers before you started out, there would be no need to go.

Just as the voyage of Columbus opened up whole new avenues for the whole human race, so I believe will our efforts in space. New knowledge often must wait years before it can be applied to advance the human condition. That's what makes research so exciting and I am certain that space offers probably the greatest potential for learning new things.

QUESTION: In these pioneer days of space exploration, women, as you know, have to a large degree been excluded--even from research.

GLENN: I wouldn't say excluded. I would say limited in that the required qualifications, certainly for space travel, have been a limiting factor.

In spacecraft, up till now, we have tried to fill those very valuable seats with those who had the best qualifications to go. It so happened that we had men who were better qualified physicists or geologists or pilots and I think it is unfortunate that it developed that way. I think we will have women traveling in space; but when they do it will be on the basis of being the best qualified among the applicants. I think in the selection program every effort was made to define the qualifications for selection. Perhaps there were women who were better qualified in geology or physics or astronomy, but they didn't apply for the program.

I think of the people who wanted to go and who were available when NASA was choosing pilot or scientist-astronauts, the best were chosen. If I were going into space tomorrow and I felt there was someone better qualified to fill the seat available in the spacecraft, it wouldn't make a bit of difference to me if that person were male or female as long as we were going to bring back the best information by putting that person in that seat.

QUESTION: Quite apart from women in space travel, statistics show that the role of women, even in ground-based research for space, is very limited, especially at high levels. Would you comment on that?

GLENN: That's something to be considered and corrected.

QUESTION: The other day, I came across this quotation from Plato. He said: "Nothing can be more absurd than the practice which prevails in our country of men and women not following the same pursuits with all their strength and with one mind; for thus the state, instead of being a whole, is reduced to a half." Would you agree with that statement?

GLENN: I want all fields to be as open to women as they are to men; but I don't know that we will ever have the number of women involved in careers outside the home that we have men. There are women, too, who consider homemaking a career and in my judgment that's as important as going out into space and being a scientist or politician or anything else. Being a wife and mother, running a home well, is an important job, too, that requires considerable executive ability and managerial skills. But I agree that opportunities for women should be as unlimited as space whatever their career choices; and the only question should be--for men or women--the matter of ability and qualifications.

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